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ABSTRACT

This guide is one of a set of 10 science guides, each covering a separate grade in Manitoba, together covering kindergarten through grade 9. The guides have been designed to provide a framework for building scientific concepts and developing the learning of process skills. They replace an earlier set of guides dated 1979. Each guide is essentially the same through the first 16 pages, after which the core units vary appropriately for each academic level. Three themes and units within those themes which are carried through the K-4 program include: (1) environmental interdependency and interaction-- reproduction and heredity/plant and animal interactions (grade 9); (2) matter and energy--force, work and motion/chemical interactions (grade 9); and (3) earth, time and space--the changing earth's crust (grade 9). Appendices include: (1) K-9 program overview; (2) science processes development: K-9; (3) science processes development: problem solving, K-9; (4) objectives and concepts for STS interactions; (5) K-9 STS content; (6) uses of computers in science; (7) safety in science; (8) women in science; (9) science fairs; (10) basic equipment lists for grades 5-9; (11) directions for using the microscope; and (12) a copy of the response questionnaire for the K-9 program of studies. (KR)

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Manitoba
Education
and Training

1991

science: grade 9

interim guide

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science: grade 9

interim guide

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manitoba education and training

1991

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This guide was prepared by Manitoba Education and Training to provide students with some basic understandings and skills in science. The interim form of this guide has been developed on the basis of feedback from teachers during the period of 1988-89. The 5-9 science program has been designed to articulate with K-4 science and to provide basic concepts and skills which will be useful to students continuing in the sciences. This guide may be used in September, 1991, in place of the previous (1979) guide.

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C. Gale, J. A. Cuddy Elementary, Morris-Macdonald School Division No. 19

M. Haines, Centennial School, Lord Selkirk School Division No. 11

E. Kuch (Writer), Robert Andrews School, River East School Division No. 9

F. Mason, Riverview School, Brandon School Division No. 40

V. Nehe, (Chairperson), St. James Assiniboia School Division No. 2

G. Shannon, Stanley Knowles School, Winnipeg School Division No. 1

T. Meadows, Faculty of Education, University of Manitoba

W. Soprovich, Curriculum Consultant, Curriculum Development and Implementation Branch, Manitoba Education and Training (until December, 1988)

E. Cicierski, Curriculum Consultant, Curriculum Services Branch, Manitoba Education and Training

E. Uzwyshyn, Curriculum Consultant, Curriculum Services Branch, Manitoba Education and Training

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INTRODUCTION

RATIONALE

The previous science curricula, designed during the period of 1976-78, were concerned with helping students to rationally process data within the context of a scientific knowledge which could sometimes be applied to student and environmental concerns. These emphases occurred because of the apparent needs of the middle years student, the impact of environmental and energy problems upon the aims of science education, and the potential effect of science and technology upon the student and society. Although the specifics may have changed since the 70's, the general needs of the 11-15 year old students and aims of science education which can satisfy these needs remain unchanged. However, the need to review an area of science education with a high impact upon students' future decisions, the increased effect of science and technology upon the individual affecting our need to understand this area, teacher feedback concerning the program, and other items have indicated a need to modify some of the emphases and design of the program.

During the last two years, teacher surveys relative to the K-6 and 7-9 science programs have been conducted. These surveys and a major Science Council report[1] indicated that a general or integrated science program should be retained which had a balance among major ideas that would aid students in applying them to his/her environment; and to provide a flexibility in the design of the program. In addition, the surveys indicated a need to review some of the space, environmental, and physical science units. Because the K-9 science program was reviewed, it was possible to examine the sequence and development of concepts and processes in such areas as the environmental theme. Thus, some units such as the Grade 7 unit on micro-organisms was modified to reflect a greater environmental emphasis.

Newspaper articles and television reports are constantly reminding us of the increasing impact that science-technology has upon humans and their environment. An introduction to the nature, strengths and limitations of science and technology occurs in this curriculum and is applied more fully in the senior years. For example, the science and technology of flight and possibilities of energy conservation are introduced and applied.

Students are bombarded with a tremendous amount of data which is sometimes conflicting and of uncertain validity. Consequently, they need skills to organize and evaluate information, and to apply scientific knowledge to life situations. In order to help students to become scientifically literate in today's society, this curriculum should begin to develop the following attributes:

- Understands scientific concepts and their applications in practical situations.
- Recognizes the strengths and limitations of science and technology and their applications to life management and societal decisions.
- Applies science processes, concepts, and values to problem-solving and responsible decisions.

---

[1] Science for Every Student. Science Council of Canada.

- Understands and respects the ethics of science and the relationship of science to other fields of learning.

- Maintains a positive interaction with their environment.

- Develops an interest in science-related skills which can be applied to lifelong learning.

AIMS (GOALS)

GOALS OF THE SCIENCE 5-9 CURRICULUM

In general, today's educational goals emphasize the need to help learners to achieve their potential as responsible individuals. These individuals will have acquired the knowledge and skills for understanding ideas and solving problems; developed respect for others, their cultures, and the environment; and remained an active learner with a productive future. The goals of science education contribute to general learning goals through experiences which help students to understand the nature of science and technology and the ability to apply their knowledge and skills to managing their lives. As a student progresses from Science 5 to Science 9, the following skills, knowledge and attitudes should be acquired:

1) An understanding and facility in applying the skills and processes of science.

   Processes of science include identifying a problem, observing, inferring, formulating models and experimenting. The complete list of processes can be found on page . In addition, an understanding of the nature and limitations of science will be developed.

   The psychomotor skills necessary for proper laboratory techniques and safe handling of equipment and materials are included.

2) A facility in problem solving using science.

   Students will be provided with opportunities to use scientific concepts and processes to define problems and reach conclusions. Some of the skills, which will be developed, include the ability to:

   - Recognize and define a problem, its central issues and assumptions.

   - Develop alternate solutions to a given problem.

   - Evaluate evidence including gathered data, print and non-print information, and the validity of conclusions.

3) The basic knowledge and attitudes* needed to function in a scientific and technological world.

   Concepts are provided in the areas of life-environment, earth-space, and physical sciences. Attitudes, to be developed, include a curiosity and interest in scientific phenomena, questioning of all things, respect for accuracy and precision, belief in cause-effect relationships, and suspension of judgment pending adequate data.

4) An understanding and appreciation of the relationship between science and technology and their relationship to society and the individual.

   Students will have opportunities to develop understandings such as:

* See Attitude and Values, page 3.

- The nature of science as a search for truth, with presently tentative understandings based upon both rational insight and chance discovery.

- The differences between science and technology and their abilities and limitations for solving problems.

- The recognition of potential implications for society of scientific discoveries.

The student is affected personally by the growth of scientific knowledge. The student should become aware of how the knowledge of science enhances personal life management. For example an understanding of such things as properties of matter and radiation, plants and animals, the environment and natural resources, chemical reactions, and appliances and machines will help students enrich and manage their own lives at school and in the future.

5) Respect for the environment and the relationship of science to issues and values.

Students will be provided with opportunities to develop a respect for living things, the nature of their interactions, and the potential effects of human decisions upon the environment. During the upper levels of the curriculum opportunities to use science information and skills to examine and clarify various social and environmental issues will be provided.

6) Awareness of the career opportunities in science and technology.

ATTITUDES AND VALUES

The student should develop positive science attitudes which can be either scientific or environmental in nature.

SCIENTIFIC ATTITUDES

1. Develop a curiosity about natural events that occur on Earth.

2. Become aware of the universe and its contents.

3. Recognize the impact of space research and space technology on communication, weather prediction, and spin-offs.

4. Value the differences that exist between organisms, including humans.

5. Foster an appreciation of technology on society.

6. Develop an awareness of how scientific research and development affect our lives.

7. Develop a concern for energy and the need to conserve energy.

8. Be aware of alternative forms of available energy.

9. Appreciate the impact of chemicals.

10. Develop a concern for safety in the home and school.

11. Deal with problems in an open-minded manner.

12. Use scientific knowledge and skills to clarify personal values.

ENVIRONMENTAL ATTITUDES

1. Appreciate the environment and the interactions of life forms within the environment.
2. Develop an awareness of threats to the environment such as greenhouse effect, acid rain and pollution.
3. Distinguish between the proper use and the misuse of chemicals on the environment.
4. Develop a responsible attitude towards managing and conserving the environment.

LEARNING THEORY AND PROGRAM DESIGN

The Science 5-9 program attempts to consider present knowledge of the intellectual and social development of middle years students and the nature of science education in designing the program. As illustrated in the aims, science education is concerned with helping students to apply concepts to their interpretation and management of their world. In the past, much has been written about intellectual development from the stage of focusing on the particular and concrete to the formal operational stage[2]. Although science education research has maintained its interest in developmental ideas, recent research has also been concerned with the efforts of students' preconceptions about the real world upon their understanding of the world as defined scientifically. A current perspective of learning maintains the view that learning is an active process with the following concepts[3].

- Students' conceptions, purposes and motivations influence the way in which they interact with learning materials in various ways. Those commonly held concepts of systems which are different from the scientific reality are called misconceptions.[4] For example, a common misconception about current electricity is that current is used up as it flows around a circuit.

- Learning involves constructing meaning as a continuous and active process. Although the meanings may appear to be incoherent to others, the student may not see the idea as incoherent. For example many young children believe that an object sinks more readily in deeper water.

- Meanings are stable; modification of a meaning is dependent upon a student's belief. Although students may be able to develop a new idea which conflicts with old, they are often reluctant to accept it and develop a new system of thinking. For example, some students in physics tend to associate constant force with constant motion and have difficulty in accepting that tables and walls, in static equilibrium, can exert forces.

[2] Osborne K. Middle Year Sourcebook: Some Suggestions for the Education of Early Adolescents. Department of Education, Province of Manitoba, 1984.

[3] Driver, R. and Bell, B. "Students' Thinking and the Learning of Science: A Constructivist View", School Science Review, March, 1986, p. 443, 456.

[4] Eaton, J. F., Anderson, C. W., Smith, E. L. "What Students Don't Know. They Don't Know", Science and Children, April, 1983, p. 7-9.

- Some meanings are shared i.e. commonly held ideas can be identified. For example, research indicates that children have a tendency to identify heat with temperature and to consider heat as having fluid properties. Heat transfer is better understood when a temperature change occurs (conduction) than when it does not (change of state)[5]. In regard to plant nutrition, many students associate food getting with the soil and have little understanding of the relationship between photosynthesis and other physical and chemical processes[6]. After all don't we say "Give that carnation some plant food?"[6]

The above learning assumptions and research findings have a number of implications for the design and teaching of science.

IMPLICATIONS OF LEARNING THEORY TO THE DESIGN AND TEACHING OF THE SCIENCE PROGRAM

Learning theory has been related to the design of the Science 5-9 program and teaching strategies in the following ways:

- The program design has attempted to provide a developmental sequence of tasks and skills whereby students are required to process data and variables. An increase in the complexity of the variables which are considered and the degree of student input or control is increased e.g. the testing of a consumer product or of a hypothesis.

- Variation among students is considered within the program design in two ways. Firstly, the program provides suggestions for a wide range of activities. Secondly, the design has been modified in order to provide additional time. The time is critical for encouraging students to hypothesize and generate models, test assumptions, and to explore concepts with others.

- A need exists to apply concepts in a variety of real-world or practical situations. For example, many students believe that steel and wood in a room are at different temperatures. Students should examine heat transfer and temperature with a variety of materials. The science-technology-societal theme encourages application in topics such as flight or the design of models.

- Language development correlates highly with the development of reasoning skills according to a number of research studies. Teachers should consider the following activities to support the development.

  a) Incorporate reporting tasks where connective terms such as "since, hence, similarly" are required to summarize results.

  b) Use examples that require formal reasoning with concrete situations.

  c) Provide practice in visualizing and verbalizing concepts and ideas.

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[5] Brook, A. et al. Aspects of Secondary Students' Understanding of Heat. Centre for Studies in Science and Mathematics Education, The University of Leeds, 1984.

[6] Bell, B. et al. Plant Nutrition. Centre for Studies in Science and Mathematics, University of Leeds, 1985.

- Since students are developing more sophisticated understandings over time, the curriculum design has included aspects of a spiral curriculum within some of the themes.

- Pupil interaction with concrete situations requires that teachers spend the necessary class time getting students to make sense of their experiences and by helping them connect activities to past and future science knowledge. This can be supported by determining students' ideas (including misconceptions) early in a unit creating situations whereby they must clarify their ideas, evaluate alternatives, and apply them in a range of situations. This can be achieved by focusing on the processes rather than on the content of science.

SELECTION AND USE OF CURRICULUM MATERIALS

In this revised course, the curriculum consists of the objectives of each unit as listed in the expanded outline. The materials presently in the schools as well as the materials which will be recommended on an ongoing basis by the Department of Education and Training are to be used by students and teachers to develop the concepts or skills specified in the objectives. Teachers are encouraged to seek out additional materials which will provide them with assistance in planning their lessons.

GENERAL PROGRAM OVERVIEW AND ESTIMATED TIME ALLOTMENTS

THEMES	5	6	7	8	9
ENVIRONMENTAL INTERDEPENDENCY AND INTERACTION	Adaptations to Environment	Interactions of Populations with Environment	Microbes and Ecosytems (22)	Cells and Organ Systems (24) --- Plants and the Environment	Reproduction and Heredity (18) --- Plant and Animal Interactions (24)
CHANGES IN MATTER AND ENERGY	Electric Charges --- Force and Motion --- Physical and Chemical Changes	Force and Motion --- Machines ---	Light (22) --- Physical Properties (16) --- Physical Changes of Matter	Heat (22) --- Alternative Energy Forms (16) --- Flight (22)	Force, Work and Motion (18) --- Chemical Interactions (18)
EARTH, SPACE AND TIME	Changing Earth	Weather --- Earth in Space	Rocks, Minerals and Soils (24) --- The Observable Universe (16)		The Changing Earth's Crust (22)

NOTE: Grades 5 and 6: Recommended 30 minutes per day for science. Units are of approximate equal length.
Grades 7, 8 and 9: Estimated time (hours) per unit.

SCOPE AND SEQUENCE

THEME	GRADE K	GRADE 1	GRADE 2	GRADE 3	GRADE 4
INTER-DEPENDENCY AND INTERACTION	LIVING AND NON-LIVING . characteristics . plants as living organisms, growth needs	ANIMALS . animal characteristics . comparison of different animal properties . animal care OURSELVES . variations and comparisons among people characteristics	ORGANISMS IN THE ENVIRONMENT . properties unique to six animal groups (insect, birds, mammals...) . properties of deciduous trees and plant needs . organisms - response to stimuli . animal-plant characteristics and habitats . man's interactions	LIFE CYCLES . complete and incomplete metamorphosis . animal behaviour and instinct	POPULATION INTERACTIONS . nature of a population and habitat . animal interdependency herbivores, carnivores, omnivores, and predator-prey . food recycling, food chain and web . population - environment interactions . human interactions

SCOPE AND SEQUENCE

THEMES	GRADE 5	GRADE 6	GRADE 7	GRADE 8	GRADE 9
INTER-DEPENDENCY AND INTERACTION	ADAPTATIONS TO THE ENVIRONMENT . structural and behavioural adaptations (plants and animals) . Adaptations related to distribution, reproduction and survival	INTERACTIONS OF POPULATIONS WITHIN THE ENVIRONMENT . populations needs and competition . Producers and consumers . Human dependency and interaction with environment	ENVIRONMENT . ecosytems-interaction of biotic and abiotic factors . yeast is a decomposer . Factors affecting population growth in a yeast culture . microorganisms - benefits and harm	ENVIRONMENT . factors involved in photosynthetic process . growth and soil . plant respiration . plant role in environment and with man CELLS AND ORGAN SYSTEMS . organization - cell to system . structure and function - circulatory and respiratory systems . Health problems and solutions	INTERACTIONS . interactions-competiton to commensalism . energy changes in food chains to pyramids . Nature of succession . Management REPRODUCTION AND HEREDITY . asexual and sexual cellular reproduction . human reproductive system, structure and cycles . variations in human traits . genetic control and prediction

SCOPE AND SEQUENCE

THEME	GRADE K	GRADE 1	GRADE 2	GRADE 3	GRADE 4
MATTER AND ENERGY	PROPERTIES OF OBJECTS . senses help determine properties of objects (size, colour, shape, texture, hardness, weight) . classification and identification from properties . change in properties	PROPERTIES OF MATTER . materials have unique properties, can identify . characteristics of solids and liquids . changes in solids' properties (dissolved, heated) . patterns and order in change	FLOATING AND SINKING . objects vary in ways they float . different liquids and shape affect an object's floatation . depth of a liquid has no effect . designs of objects can be tested for floatation	CHANGES IN MATTER . matter made of parts . particles in liquids and gases . separation in mixtures . liquids vary in properties . nature of physical change AIR AND AIR PRESSURE . properties of air . warm air rises . air contains water vapour HEAT AND TEMPERATURE . heat energy causes motion . expansion and contraction . temperature measurement . conductors and insulators . absorption - colour	SOUND . sound caused by vibrations, pitch . sound travel - direction, loudness . sound conductivity . sound pollution and control STRUCTURES . cell structure and characteristics . skin and skeletal structures - materials, size and strength . size, shape design and materials affect a structure's strength ELECTRICITY . single cell circuit and switch . several cells circuit (one bulb) . series and parallel circuit . conductors, insulators and the light bulb

SCOPE AND SEQUENCE

THEME	GRADE 5	GRADE 6	GRADE 7	GRADE 8	GRADE 9
MATTER AND ENERGY	CHEMICAL AND PHYSICAL CHANGE . properties identify objects . characteristics of physical change (shape, size, state mixtures) . chemical change characteristics ELECTRIC CHARGES . static electricity - nature and production . electric current - chemical production, electro magnetism, applications FORCE AND MOTION . unbalanced forces on motion . weighing objects - balance beam and spring scale . transmission of forces and test of strength	FORCES AND MOTION . force on an area . factors affecting floatation and design of floating objects FORCE AND MACHINES . effort and resistance relationships (six simple machines) . lever, inclined plane and pulleys relationships are quantitative . complex machines contain two or more simple machines	PHYSICAL PROPERITIES . changes in state, water cycle . fusion, vapourization and temperature . factors affecting solutions and separation . properties of industrial products, testing LIGHT . transformation of light energy . light transmission - reflection and refraction . light and colour . uses of lens	HEAT . heat and temperature . energy transformations to heat . heat transfer and applications . expansion, contraction and applications . alternative sources ALTERNATIVE FORMS OF ENERGY . formation or production of fossil, solar, nuclear, wind, and hydro-electric energy . cost-benefits of alternatives FLIGHT . factors affecting . lighter-than-air flight . forces and controls on heavier-than-air flight . design factors . flight in space	CHEMICAL COMPOSITION AND CHANGE . characteristics of chemical change . elements, atoms, compounds and reactions . conservation of matter . acids and bases, characteristics and tests . household chemistry and safety FORCE-WORK MOTION . unbalanced forces, gravity . quantitative relationships within simple machines . mechanical advantage, work and efficiency . friction effect on efficiency

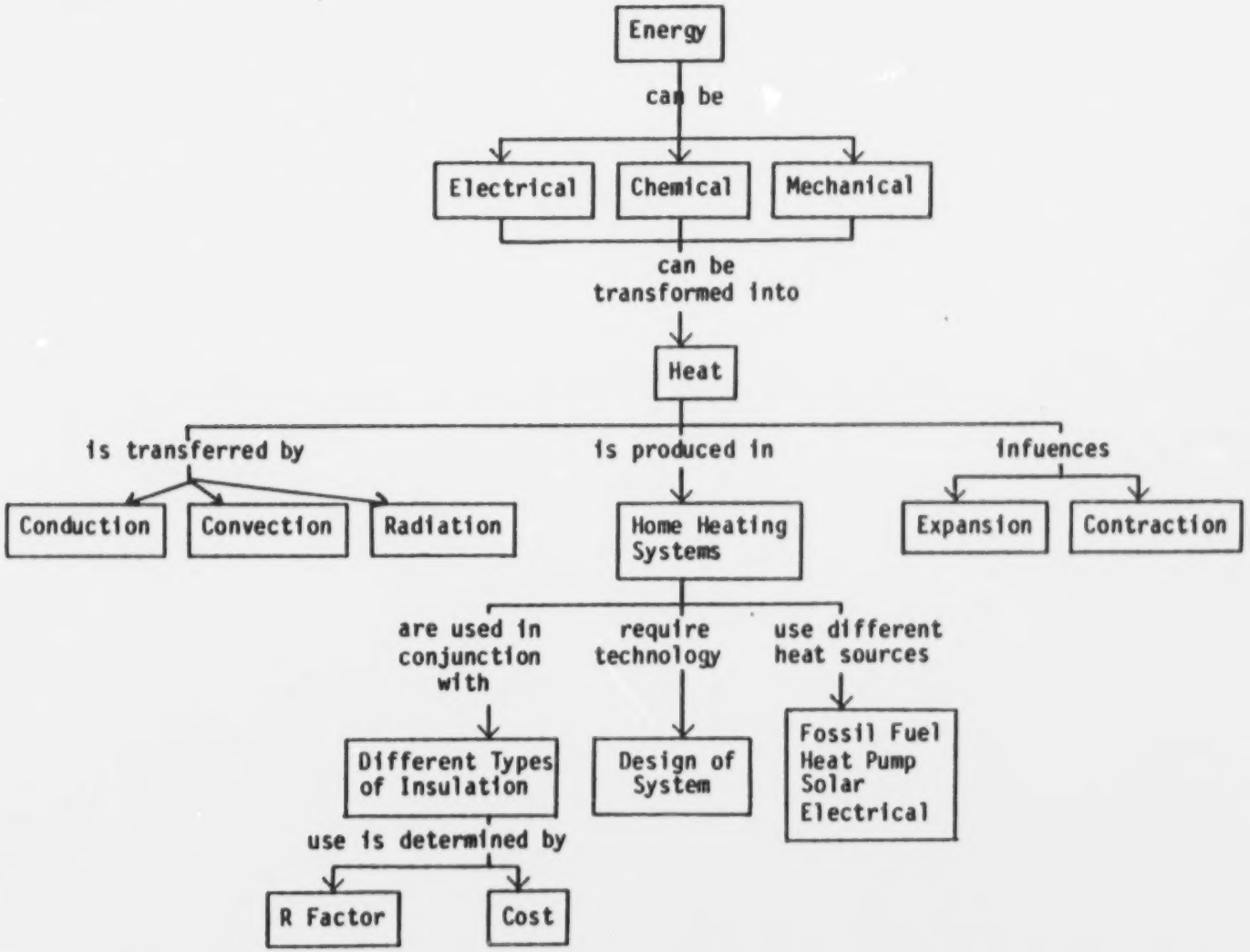
SCOPE AND SEQUENCE

THEME	GRADE K	GRADE 1	GRADE 2	GRADE 3	GRADE 4
EARTH, TIME AND SPACE	SIZE, POSITION AND TIME . size comparisons (non-standard units) . reference points and position . ordering of events	COMPARING AND MEASURING EVENTS . regular and irregular events . events in time sequence . time measurement (non-standard and standard units)	MEASURING TIME AND POSITION . time measurement - standard units . size and distance - standard units . position location measurement LIGHT AND SHADOWS . light position and size, nature of shadows	SUN, EARTH AND MOON . light reflection and conduction . sun - object shadows . relative position - night and day, moon phases THE OBSERVABLE UNIVERSE . location using a coordinate system moon characteristics and earth-moon interactions . characteristics of sun as a star . constellations, galaxies . technology of space	WATER AND LAND . erosive effects of water . factors effecting erosion . absorption of water into land . water cycle . conservation

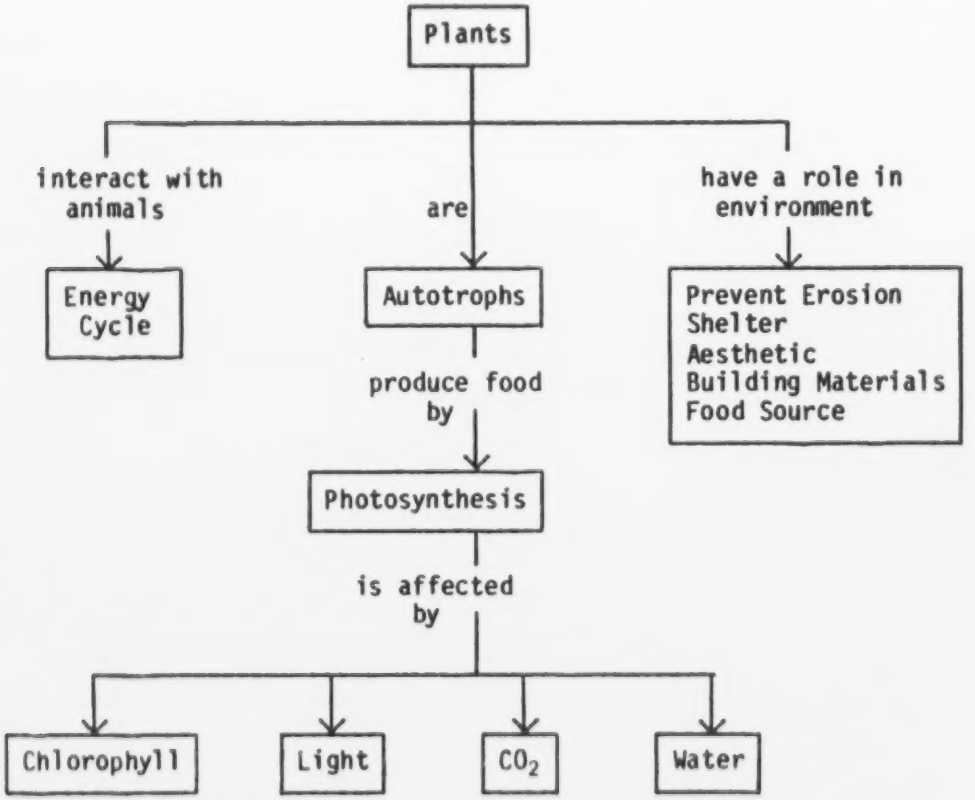
SCOPE AND SEQUENCE

THEME	GRADE 5	GRADE 6	GRADE 7	GRADE 8	GRADE 9
EARTH, TIME AND SPACE	CHANGING EARTH . rocks and minerals . sedimentary rock formation . fossil formation	EARTH IN SPACE . rotation and time . revolution and seasons . planets in the solar system . technology for observation WEATHER . factors affecting air movement . humidity, air movement relates to cloud formation and precipitation . weather and air masses, prediction and technology	ROCKS, MINERALS AND SOILS . igneous, sedimentary and metamorphic rocks . the rock cycle . testing of minerals . uses of rocks and minerals . nature and production of soil . erosion and soil management THE OBSERVABLE UNIVERSE . location using a coordinate system moon characteristics, and earth-moon interactions . characteristics of sun as a star . constellations, galaxies . technology of space		THE CHANGING EARTH'S CRUST . Alternate theories for continental structure . evidence for plate tectonics theory . technological support . relationship of plates to volcanoes, earthquakes and mountains

GRADE EIGHT: CHANGES IN MATTER AND ENERGY: HEAT

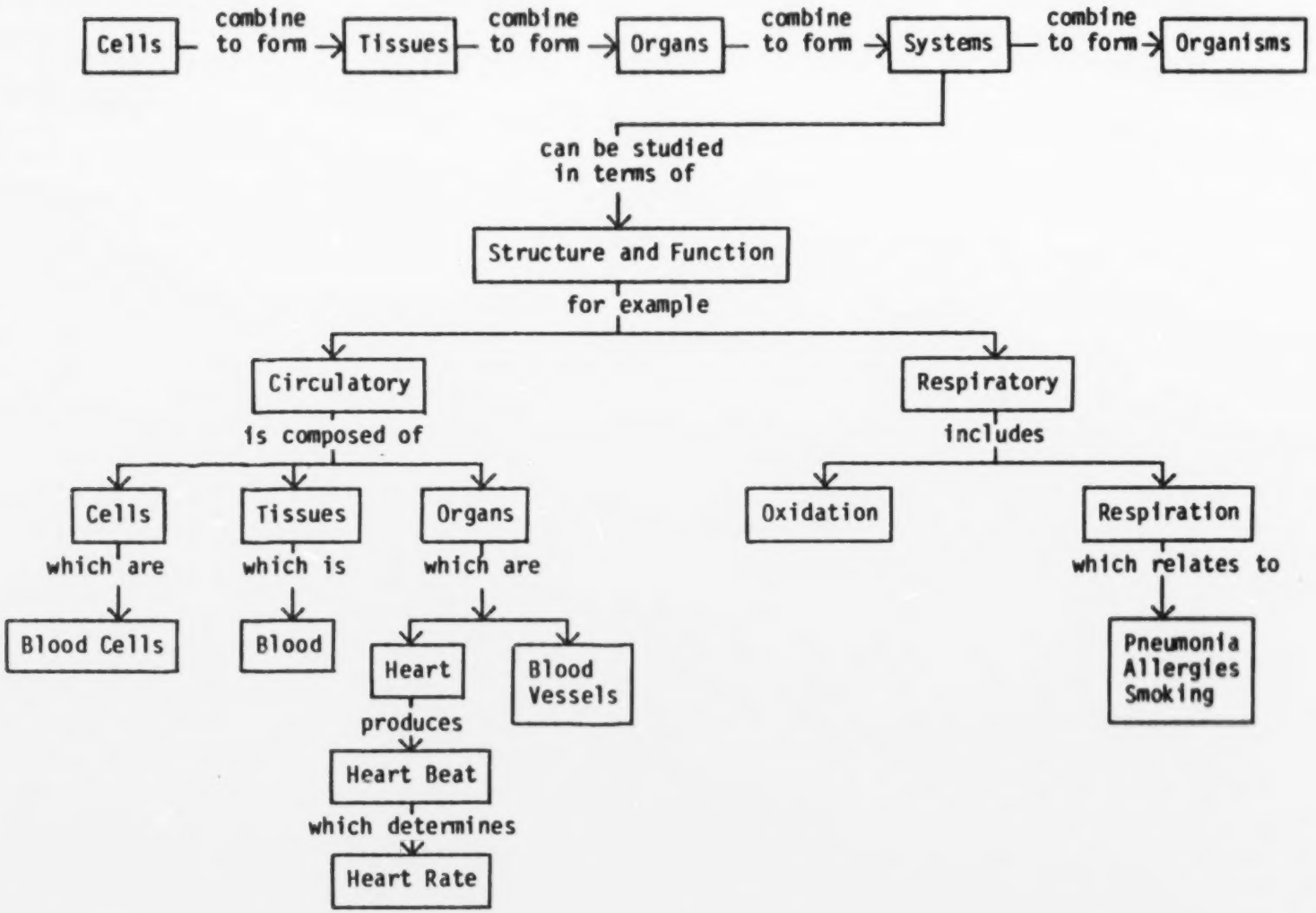


GRADE EIGHT: ENVIRONMENTAL INTERDEPENDENCY AND INTERACTION AMONG ORGANISMS: PLANTS AND THE TOTAL ENVIRONMENT

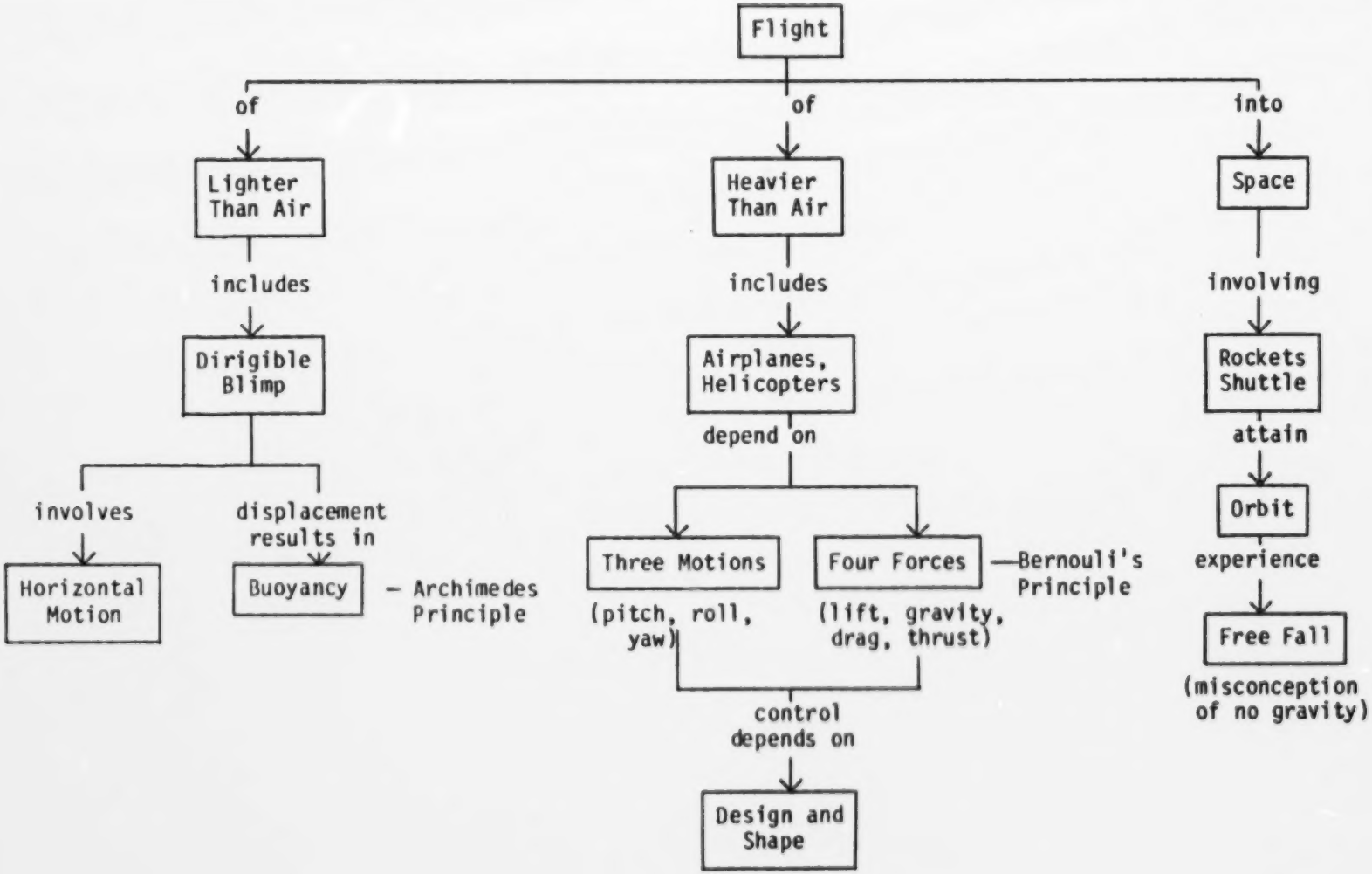


NOTE: Misconception: Soil Provides the mass of a plant.

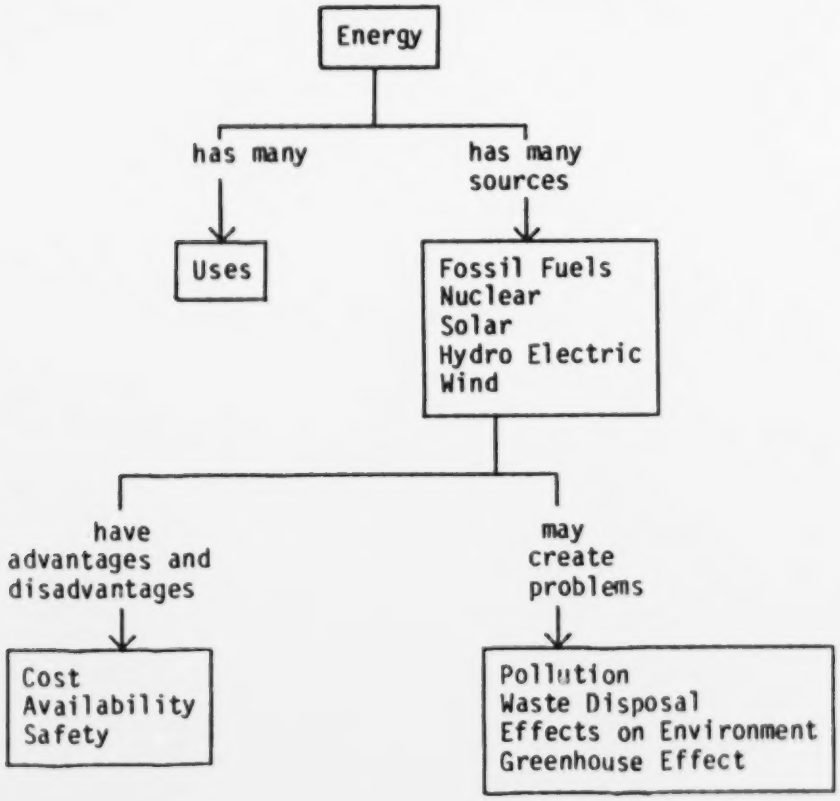
GRADE EIGHT: ENVIRONMENTAL INTERDEPENDENCY AND INTERACTION AMONG ORGANISMS: CELLS AND ORGAN SYSTEMS



GRADE EIGHT: CHANGES IN MATTER AND ENERGY: FLIGHT



GRADE EIGHT: CHANGES IN MATTER AND ENERGY: ALTERNATIVE FORMS OF ENERGY



ORGANIZING A SCIENCE PROGRAM

PROCESSES OF SCIENCE

Inquiry in science can be represented by specific intellectual skills entitled "processes." Processes are identifiable behaviours, used by scientists which can be generalized across content domains. These behaviors contribute to rational thinking in everyday affairs. In order to become an increasingly active and dynamic investigator of science the student needs to use the processes of the scientist. Through conscious, systematic development of these processes, the student will become increasingly better equipped for more complex learning in the fields of science as well as other areas of investigation.

Observing

Observing is one of the basic process skills of science. It involves obtaining information about objects, situations or events using the five senses. Observations may be qualitative or quantitative in nature. Observing provides both a basis for new inferences or hypotheses and a tool for testing existing inferences and hypotheses.

Measuring

Observations are quantified using non-standard and then standard units. Length, area, volume, mass, time intervals and force are among the measurements which are used. Appropriate measurement instruments and units within the metric system are selected. Examples of measurement include "using paper clips as standard units for measuring an object," "calibrating a scale," and "measuring the rate of hatching organisms."

Classifying

Classifying is the grouping of objects, concepts or events on the basis of some observable properties in order to show similarities, differences and/or interrelationships.

Inferring

Inferring means suggesting more about a set of conditions than is observed. Inferences are based upon observed data and past experience. This may evolve from both direct and indirect evidence and are modified on the basis of new evidence. Examples of inference include "inferring the identity of objects on the basis of observing their shadows" and "inferring the kind of material (chemical) on the basis of evidence obtained from tests."

Predicting

A forecast is made about future events on the basis of ordered data. Predictions on the basis of ordered data, extrapolation beyond an observed pattern of events, and tests of predictions can be made. Examples of prediction include "predicting the appearances of adults that will grow from young animals" and "predicting the consequences of changes in an animal habitat."

Organizing and Processing Data (Communicating)

Organizing and processing data is a process that occurs between the observation stage and the interpretation or generalization stage. It usually involves the organization of "rough" data into a more compact and meaningful way (ordering, rearranging, comparing), depicting the data pictorically or graphically, and processing data mathematically (finding slopes, tangents, etc.) in order to facilitate interpretations.

Recognizing and Identifying a Problem

This process involves recognizing and focusing on problems that can be investigated. It also includes making assumptions about possible variables and the ability to delimit (narrow down) the question under investigation in order that one can proceed to work towards a solution or the ability to formulate and express relevant questions regarding living things, objects and physical events; and general relationships.

Identifying and Controlling Variables

Identifying and controlling variables involves the process of deciding which variables or factors will influence the outcome of an experiment, situation or event, and deliberately controlling all recognized variables in a systematic manner. That is, the independent (manipulated) variable is changed in a systematic way, corresponding changes in the dependent (responding) variable are observed and measured, and all other variables are held constant (controlled). This combination of relationships is referred to as a system. Examples of systems and related variables are a pendulum system where time of a swing is affected by length of the pendulum or an index card is moved a certain distance by the impact of a marble rolling down an inclined plane.

Hypothesizing

Hypothesizing is an "educated guess" about an expected relationship between two variables in an attempt to explain a cause and effect relationship. Hypotheses are based on observations or inferences about a set of events. A hypothesis should be testable; e.g., plants require light for growth.

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Designing an Experiment

Experimenting is a cause and effect test between two variables. All processes may be involved. This can begin with setting a problem to be solved, identifying the variables to be controlled, making operational definitions, devising the test to be carried out and to follow the prescribed procedure.

Interpreting Data

Interpreting is the process by which sense is made out of the observations in the form of inferences, generalizations, or explanations: the generalizations are often a relationship between the independent (manipulated) and dependent (responding) variables. It usually is a direct response to the problem under investigation and, therefore, includes judgements about the interpretation, to fit with proposed hypotheses, and the limitation of the new knowledge. The explanation or generalization thus generated adds to the student's "body of knowledge" in science.

Defining Operationally

A process whereby objects or events are defined in a way which can be observed, used, or tested; e.g., the candle is out when a puff of smoke appears, or hot meaens any temperature over 60 degrees Celsius.

Formulating Models

This process involves the use of physical or mental models while describing the behaviour of something that is unfamiliar in terms of something whose behaviour is familiar. Constant vigilance is necessary to ascertain the validity (fit) of the model or analogy with the phenomenon modeled. Models often have to be revised in order to accommodate both old and new facts.

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SCIENCE PROCESSES DEVELOPMENT

SCIENCE PROCESSES	GRADE 5	6	7	8	9
1. Recognizing and Identifying a Problem					
1.1 Recognize patterns and events	D				
1.2 Delimiting and phrasing a problem	D			E	
1.3 Identifying relevant and irrelevant information	D				
2. Observing					
2.1 Use of the senses	D				
2.2 Use of tools to assist observations	D				
3. Measuring					
3.1 Use of instruments with precision	D				
3.2 Construction of simple measuring devices (scales, hygrometers)	I	D			
3.3 Verifying the accuracy of measuring devices	I				
4. Classifying					
4.1 Comparing materials or data	D				
4.2 Classifying and ordering based on a set of keys and criteria	D				
5. Inferring					
5.1 Generalizing data	D				
5.2 Determining adequacy of data as a basis for inferences	D				
5.3 Inferring relationships				I	D
6. Communicating					
6.1 Use of traditional methods (drawing, graphs)	D				
6.2 Mathematical treatment of data				I	D
6.3 Use of non-traditional or technological devices (tapes, discs, pictures)	D				

NOTE: Code - I - Introduced
D - Developed
E - Extend process - Student controlled and directed.

SCIENCE PROCESSES	GRADE 5	6	7	8	9
7. Predicting					
7.1 Identifying and testing prediction	D	----	----	----	----
7.2 Predicting quantitatively based on interpolation and extrapolation	D	----	----	----	----
7.3 Predicting based on application of mathematical formula					I
8. Controlling Variables					
8.1 Identify relevant variables	D	----	----	----	----
8.2 Identify the control variables				I	D
9. Hypothesizing					
9.1 Evaluate existing information	D	----	----	----	----
9.2 Correctly state a hypothesis	D	----	----	E	----
10. Interpreting Data					
10.1 Recognize valid interpretations	D	----	----	----	----
10.2 Recognize limits of interpretations (staying within the data)	D	----	----	----	----
10.3 Offer alternative explanations				I	D
11. Define Operationally					
11.1 Construct simple definitions based on experiences	D	----	----	----	----
11.2 Use mathematical as well as verbal definitions				I	D
12. Designing an Experiment					
12.1 Select appropriate techniques	I	D	----	----	----
12.2 Select appropriate techniques for observation and measurement	I	D	----	----	----
12.3 Select appropriate techniques for recording of data	I	D	----	----	----

NOTE: Code - I - Introduced
D - Developed
E - Extend process - student controlled and directed

SCIENCE PROCESSES	GRADE	5	6	7	8	9
13. Formulating Models						
13.1 Generate spatial models		I	D----------			
13.2 Generate mathematical models						I
13.3 Critically examine models						I

Note: Code - I - Introduced
D - Developed
E - Extend process - student controlled and directed

PROBLEM SOLVING AND SCIENCE, TECHNOLOGY AND SOCIETY

To prepare a student's facility in problem solving is a goal, which is generally found among today's curricula statements. Mathematics develops skills in analyzing quantitative data and spatial relationships as tools in problem solving; social studies promotes an understanding of documental evidence and the role of values in examining social problems; and technical-vocational studies provide opportunities to solve design and practical problems. Science education, when developing scientific processes and using inquiry within a scientific context, is emphasizing a problem solving approach.

Problem solving is sometimes considered to be the solution to a word problem whereby an obvious algorithm is available to the learner e.g. a type problem. Although this interpretation of problem solving may be useful in the development and application of certain concepts, for our purposes, problem solving is defined as a process whereby a student defines and seeks a solution to a recognized problem. As such, it is more open, a process of exploration and discovery, and the development and use of skills of experimentation and testing. Although no single method exists relative to the development of problem solving skills, the following skills[6] are generally accepted in many problem solving models:

- defining the problem in a resolvable form;
- obtaining data;
- organizing data;
- analyzing data;
- generalizing and synthesizing the data;
- decision making.

[6] Good, R. and Smith, M. "How do We Make Students Better Problems Solvers": Science Teacher, April, 1987, p.p. 31-6.

This general model can be applied in a variety of situations within the science program.

The nature of science-technology and its interaction with society offers a variety of opportunities for incorporating the goal of problem solving. The following examples indicate some possibilities:

- The nature of science can be initially illustrated with younger children by using investigations with magnets or batteries and bulbs to develop process skills. With older students, the development of an understanding of the appropriateness or uncertainty of data and strategies of inquiry are an important part of problem solving.

- The nature of technology and its interaction with ourselves provides a number of opportunities for developing problem solving skills. One possibility is that of resolving problems in the consumer area such as determining the best cleaning product or fabric.[7] Designing and testing of potential technological solutions offers additional possibilities. For example, students could work with the problem of designing a simple bridge using a limited number of straws and testing its strength or constructing and testing the effectiveness of a solar cooker.[8]

[7] The University of the State of New York. Technology Education: Introduction to Technology; The State Education Department, Albany, N. Y., 1987.

[8] McGregor Ann and Scott. Bridges: A Project Book Lothrop, Lee and Shephard Books, N.Y., 1980. Householder, D.L. and Marshall J. "An Introduction to Solar Energy "Industrial Education, September 1984.

SCIENCE, TECHNOLOGY AND SOCIETY

It is useful to consider science and technology as specialized and related problem solving processes. Science is the process that may be used to attempt to answer questions and provide knowledge about the universe and living things and materials in it. Technology is the process by which products and systems are developed to satisfy recognized needs. To design and make these products or systems, the findings of science are used. A Science, Technology and Society (STS) emphasis in the science program attempts to help students understand the applications of science and how this related to the world around them, making science more relevant.

For example, the given concept might be: a technological process or device often builds on past ones, becomes obsolete or can be changed and improved. Improvement may decrease the cost of the process. The program's objective would be: the student should be able to explain why some processes become obsolete. The activity would provide the student with the means by which the objective can be achieved.

Each STS activity in the 5-9 science program has been identified with two asterisks (**) beside it. Teachers are encouraged to find or develop other examples.

SUSTAINABLE DEVELOPMENT STRATEGIES

Sustainable development is the process of maintaining our natural heritage. It is important that students are made aware of the need for judicial use and management of our natural resources. The students are the stakeholders. They need to be informed about environmental concerns and the economic devastation which occurs due to a lack of environmental protection.

A Sustainable Development Strategies (SDS) emphasis in the science program will allow students to identify the areas in which environmental damage is taking place and to explore methods by which the environment can be protected. This SDS emphasis begins in kindergarten and continues throughout the entire science curriculum.

Some units lend themselves more to SDS activities and discussions than others. Teachers are encouraged to develop and foster SDS awareness whenever the opportunity arises.

This guide identifies the SDS related objectives with three asterisks (***) beside them.

5-9 PROGRAM OBJECTIVES: SCIENCE, TECHNOLOGY AND SOCIETY

OBJECTIVES	5	6	7	8	9
Students will be able to distinguish between science and technology	X	X	X	X	X
Identify scientific principles upon which a simple technology is based	X	X	X	X	X
Identify examples of interdependence of science and technology		X	X	X	X
Identify components of a functioning technological system with inputs, outputs, feedback, control	X	X	X	X	X
Describe how technological processes or devices are related to one another	X	X	X	X	X
Explain how technology extends the abilities of human beings	X	X	X	X	X
Explain why a technological process or device becomes absolute		X	X	X	X
Demonstrate how science, technology and society interrelate		X	X	X	X
Demonstrate that technology has improved standard of living	X	X	X	X	X
List examples of the impact of technology on jobs and careers			X	X	X
Recognize that science and technology alone cannot solve society's problems			X	X	X
Demonstrate that processes and devices are developed in response to needs	X	X	X	X	X
Demonstrate that certain processes or devices are not accepted because of attitudes		X		X	X
Report on the need for funds to support R & D				X	X
Identify advances in technological processes and devices that result in nations interacting as communities				X	X
Describe probable long and short term consequences of a technological process or device		X		X	X
Accept or reject a process or device based on advantages and disadvantages		X	X	X	X
Demonstrate that several solutions may exist to technological issues			X	X	X
Cite examples in which legislation has been passed to regulate a process or device				X	X

62 CODE: The "X" indicates the grade level in which activities relating to each objective can be found. 63

OBJECTIVES	5	6	7	8	9
Identify advances in technological processes and devices that result in nations interacting as communities				X	X
Describe probable long and short term consequences of a technological process or device		X		X	X
Accept or reject a process or device based on advantages and disadvantages		X	X	X	X
Demonstrate that several solutions may exist to technological issues			X	X	X
Cite examples in which legislation has been passed to regulate a process or device				X	X

CODE: The "X" indicates the grade level in which activities relating to each objective can be found.

NOTE: Refer to Appendix "E" for information on K-9 content: S.T.S.

IMPLEMENTATION: THE PRINCIPAL'S ROLE AND PROGRAM EVALUATION

Within a school board's plans for program evaluation and implementation, the principal of a school has an important leadership role. This role includes the following activities:

- Encouraging a shared management plan of implementation for the science program by providing opportunities for cooperative planning.
- Monitoring the degree of implementation and staff needs.
- Determining the implications of the curriculum for staff training and facilities.
- Providing easy access to the materials and facilities needed for the program.

Program Design Implications

- Like the former design, the new science program is based on the assumption that a general science approach is more applicable to middle years students than a discipline-centred approach. The emphasis on the development of basic concepts and processes has been retained; however, a greater emphasis has been placed on problem solving and the relationship between science, technology and society. The program design implies that teachers of science should have a broad background in the sciences and endorse the interaction of science with the other areas of study.

- The number of units per year have been decreased from the previous program in order to enable schools to increase the emphasis upon science, technology and problem solving; however, new units such as flight, microsystems, and the changing earth's crust may require specific kinds of in-service support.

- Units such as reproduction and heredity (IX) and plant and animal interactions (IX) provide possibilities for integration with other areas of study. Provision of a plan for coordinating staff efforts would be important.

- The program is based upon the premise that schools have sufficient equipment and materials to carry out the necessary activities. Provision of necessary equipment and facilities is critical and a source of funds should be available whereby teachers can easily obtain materials locally.

- Materials will be developed and recommended to support the program. However, schools should continue to search for additional materials which may suggest different teaching emphases and offer different reading levels and student activities.

- The system of measurement used in science courses is SI. By the end of Grade 8, students should know basic SI units in length, area, volume, mass, and speed, simple conversions such as mL to L and familiarity with the newton and joule. Maintaining an emphasis upon the use of these units in the sciences, as well as related disciplines, is necessary.

Program Evaluation

Evaluating the effectiveness of the science program and cooperatively, with teachers, determining methods of achieving the important curriculum objectives is a critical role of leadership. Many sources of data and approaches can be used, such as:

- Evaluation of student achievement and analysis of the methods of evaluation.
- Determining needed teaching strategies and relative emphases upon program goals, the implications and needs for new teachers or teachers from another subject area, and general teacher preparation.
- Evaluation of the status of resource materials and facility needs.

Additional sources of information about program evaluation are:

Mechling, Kenneth R., "Taking Change: How Principals Can Improve School Science Programs," Principal January 1983, pp. 16-21; and,

Mechling, Kenneth R. and Oliver, Donna L., Promoting Science Among Principals: Handbook I-IV, National Science Teachers' Association, 1742 Connecticut Avenue, N.W., Washington, D.C., 1983.

STUDENT EVALUATION

The general purposes of student evaluation are to provide a) students with an understanding of their development and needs, b) teachers with a basis for planning necessary changes in teaching strategies and the curriculum, and c) information for parents and administrators. Evaluation should be related to program objectives and should consider a balance among science processes, manipulative and problem-solving skills, and content. Further, evaluation must be continuous and use a variety of approaches from informal observation of student activity to formal, such as achievement tests, performance (practical) items, checklists, and anecdotal records.

Some Evaluation Techniques

Informal observation techniques whereby teachers observe individual and group interactions in an activity can help to determine necessary skill development and the techniques required to improve these skills. Formal techniques include achievement (pencil and paper) tests and performance (laboratory) tests; checklists of processes, attitudes, and manipulative skills; and the examination of products such as oral presentations, reports and projects.

Partial Science Processes Checklist (5-9)

Monitoring student achievement in science processes may be helped by observing student behaviour in applying the processes. Samples of some behaviours are indicated in the following chart:

Process	Checklist of Behaviour
Measuring	Uses basic metric units as a standard; estimates, has basic concept of calibration (4-6). Uses simple measuring instruments with accuracy and precision; calibrates simple instruments; identifies appropriate standards for measuring lengths, area, volume and mass (7-9).
Classifying	Sorts objects into two sets on the basis of one property, two properties (4-6). Distinguishes between useful and relevant data, and irrelevant data; classifies a set of objects into two subsets; uses keys to identify objects and identify patterns (7-9).
Predicting	Predicts a change which is most likely to occur in a system after several observations; identifies a role for changes in a system; interpolates and extrapolates from simple graphs (4-6). Interpolates and extrapolates from more complex graphs; identifies or designs tests for predictions from data, begin to construct revisions of predictions based on additional information (7-9).

Manipulative Skills (Checklist)

Skill

- Sets up and stores apparatus safety
- Uses measuring instruments correctly
- Safe use of apparatus
  - heating
  - testing of compounds, e.g., no tasting)

Sample Performance Items

These items may be used individually or in a group (station) setting to test process and manipulative skills:

Bouncing Balls

Purpose: To test observing, measuring, interpreting and inferential skills.

Procedure: Provide students with three different balls labelled A, B and C, three different surfaces (board, rubber, carpet), metre stick and masking tape. Ask students to find out which ball will bounce best on all surface area. Ask them to record how they are going to solve the problem, record data, and justify their conclusions.

Microscope

Purpose: To test microscope skills, safety skills and observational skills.

Procedure: Ask students to identify labelled parts, to focus the microscope on coloured threads on a glass slide and identify the colour of the top thread; focus on and draw a letter "e" drawn on the slide; and focus on a cell (identify some parts).

References

Doran, R.L. Basic Measurement and Evaluation of Science Instruction. National Science Teachers' Association, 1980.

Hedges, W.D. Testing and Evaluation for the Sciences in the Secondary School. Wadsworth Publishing Company, 1966.

ADD OTHERS

CONCEPT MAPS

A concept map is a means by which the organization of subject matter is represented by a diagram. It is a two dimensional device which shows not only the concepts but the relationships among them. The relationships are represented by the words on connecting lines.

The concept map shown at the beginning of each unit will provide the teacher with a tool to plan, teach and evaluate. Each concept map serves as a model and teachers are encouraged to develop their own concept maps.

MISCONCEPTIONS IN SCIENCE

Misconceptions represent complete systems of explanations which are conceptually wrong. They are personal, in that students construct their own meanings from their own experiences. The misconceptions may seem incoherent to others, but the student doesn't see ideas as incoherent. The misconceptions are often stable; and even though new ideas are taught the old ones will remain. Some examples of misconceptions are:

1) that the mass of soil decreases as a plant is growing.

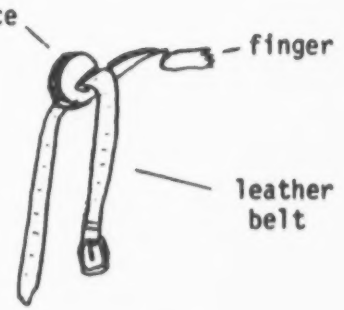
2) that molecules expand to make an object larger when it is being heated.

3) that the process of respiration is the breathing exchange of carbon dioxide and oxygen.

DISCREPANT EVENTS

A discrepant event involves a happening contrary to students' current beliefs.

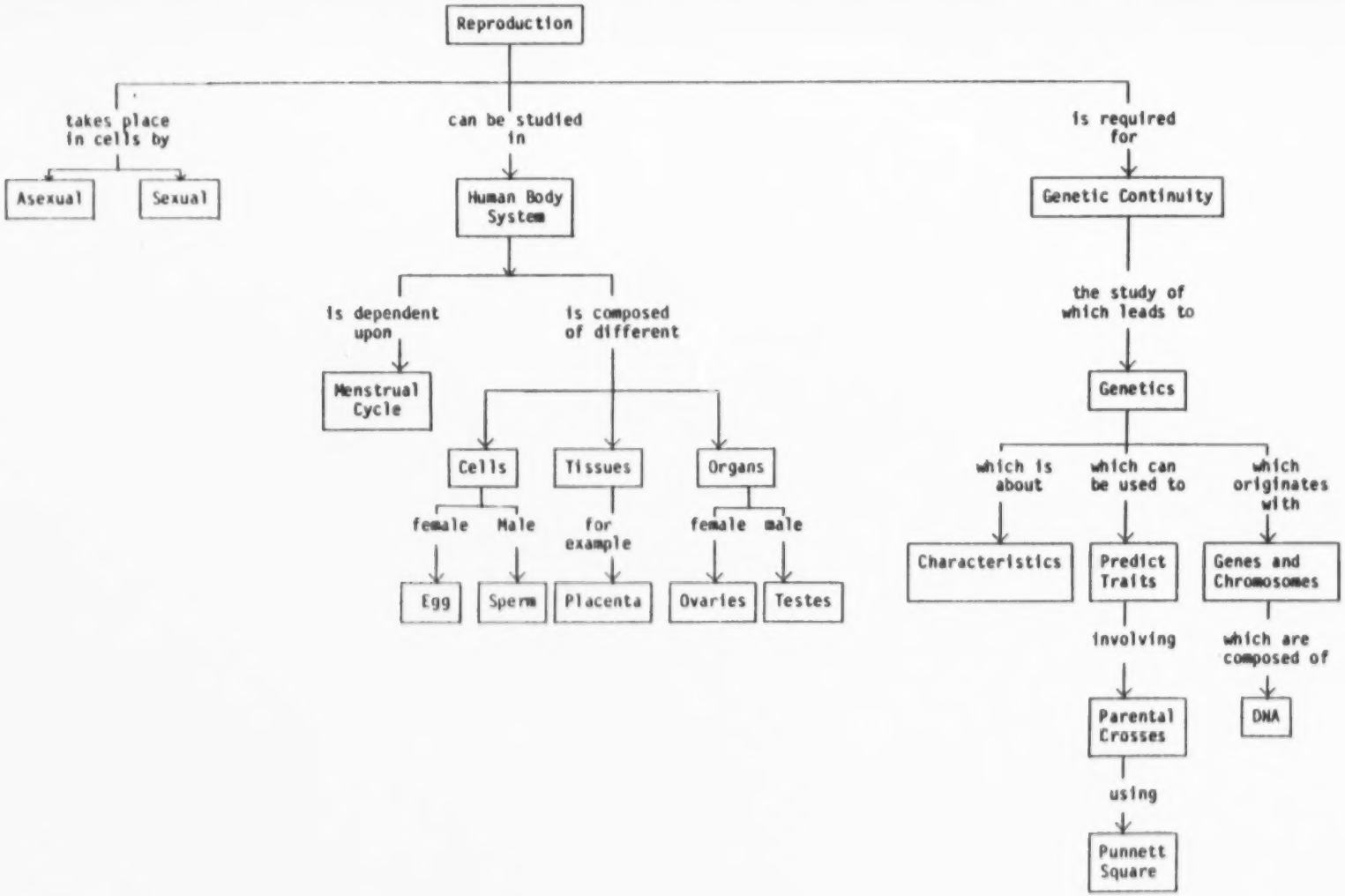
For example:



In this example, the students believe that the belt and the wooden stick cannot balance on the finger tip. This activity becomes motivational. It sparks their interest and gets students excited about science. When they see a discrepant event most students begin to wonder why and feel the need to have their questions answered.

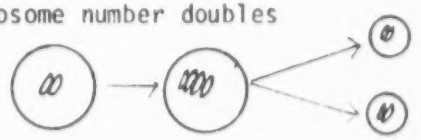
Besides motivating students to learn scientific principles, discrepant events also provide a focus for fostering problem solving skills.

GRADE NINE: ENVIRONMENTAL INTERDEPENDENCY AND INTERACTION AMONG ORGANISMS: REPRODUCTION AND HEREDITY



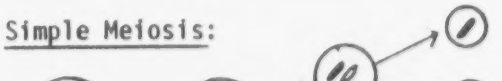
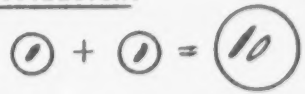
GRADE NINE: ENVIRONMENTAL INTERDEPENDENCY AND INTERACTION AMONG ORGANISMS: REPRODUCTION AND HEREDITY

RATIONALE: The survival of any species depends upon the functioning of the reproductive system. As in all body systems, the reproductive system is made up of cells, tissues and organs. Heredity or genetics is the passage of traits or characteristics from generation to generation.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
	The student should be able to:	
1. An organism must reproduce if the species is to survive.	a) Discus the need for reproduction to maintain the species.	Class discussion: A simple description of mitosis should be developed. For example: Mitosis is the process of doubling the nucleus and chromosomes. The cell then divides into two identical cells.
2. During asexual reproduction, identical copies of the cells are formed from one parent cell.	a) Define asexual reproduction.	
	b) Describe mitosis.	Chromosome number doubles  Number of chromosomes in cell. The new cells are exactly like the original cell.
	c) Observe budding in yeast.	Produce a culture of yeast. Prepare a slide and observe budding. (See Grade 7--Microbes and Ecosystems.)
3. Sexual cell reproduction requires two parents.	a) Define sexual reproduction.	
	b) Describe meiosis for the production of egg and sperm.	Use reference sources.
	c) Describe fertilization in terms of fusion and zygote formation.	

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
4. Human reproductive system is composed of cells, tissues and organs.	a) Describe the structure and function of: . egg and sperm, . placenta, . ovaries, testes, uterus.	Use reference sources.
5. Human reproduction is controlled by the menstrual cycle in females.	a) Define menstrual cycle. b) Describe the menstrual cycle. Include: . hormones involved, . body organs involved.	
6. Human development and growth occur in the uterus.	a) Define gestation. b) Describe the growth and development of the embryo and fetus.	Use charts, transparencies. Watch for programs which appear on television, such as "Miracle of Life," which shows the whole reproductive cycle.
<u>Genetics</u>		
1. Genetics is the passage of characteristics or traits from one generation to the next generation.	a) Define genetics. b) Identify traits which are easily distinguishable.	Use references. Use pictures. Make reference to a plant or have the students look at a plant and list the physical traits readily visible. Have students examine different traits such as ear lobes. Have them survey the class to determine what variations there are and which one is the most common.

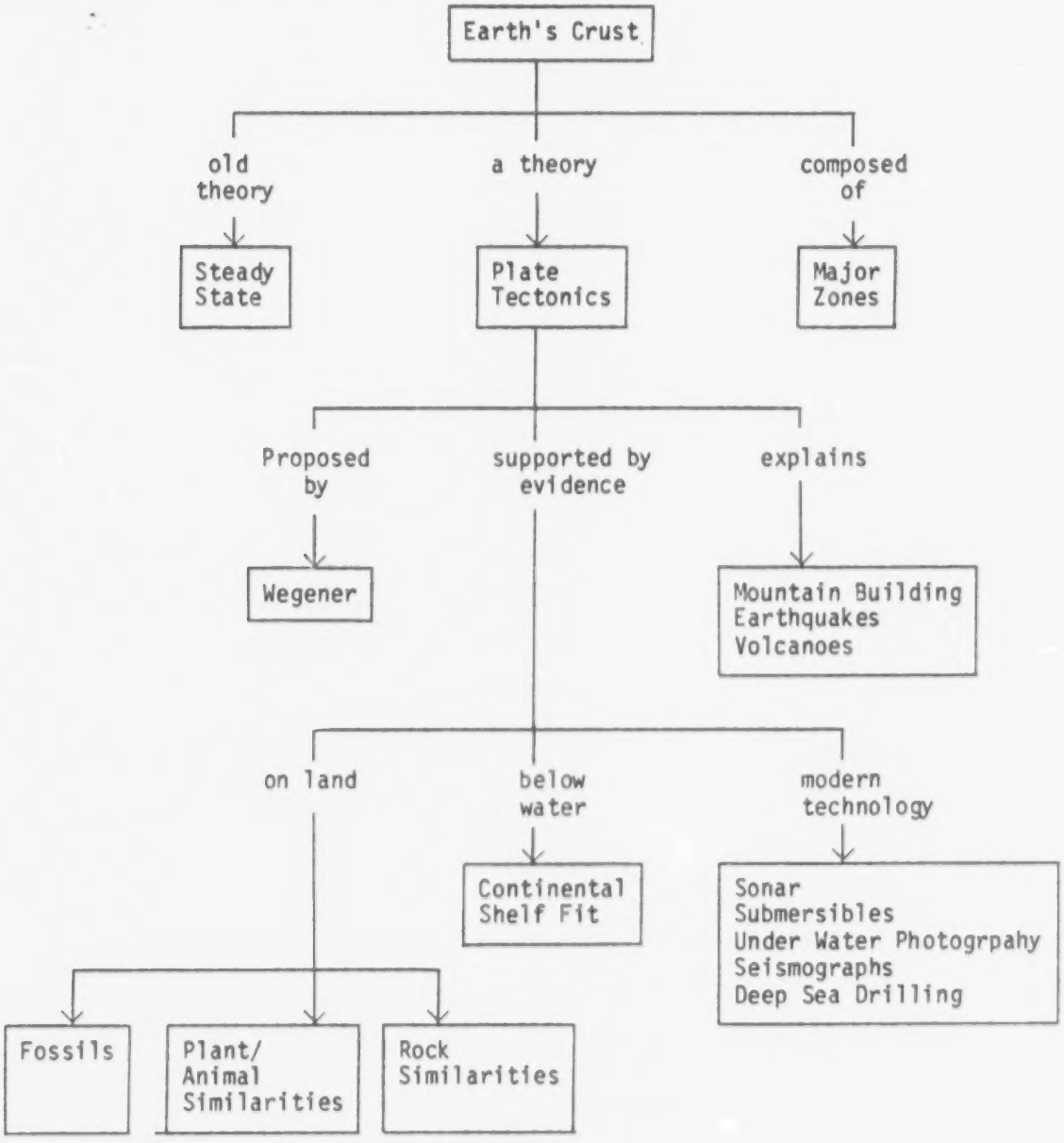
CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
2. Variations of traits exist in all organisms.	a) Define variation.	
	b) Describe the desirability or need for variations.	Students should be made aware of the need for variations if the organism is to survive. Because the environment is constantly changing, not all organisms will be able to survive.
	c) Identify variations which occur in common characteristics of a pea or bean seed.	Open up a package of seeds and have the students identify variations of colour, size and shape.
	d) Identify variations in humans.	Obtain pictures of families. Mix them up and see if students can match parents to their offsprings. Students can bring their own family pictures.
3. Genetics is controlled by chromosomes and genes.	a) Define chromosome and gene.	Prepared slides of an onion root tip can be used to show chromosomes. Most Biology texts have pictures showing genes or chromosomes of the fruit fly.
	b) Identify the role of the gene in inheritance.	
4. Each trait has basically two genes which control heredity.	a) State and discuss the Gene Theory.	Students should determine that: Genes occur in pairs. An organism obtains half of its genes from the egg and half from the sperm.
	b) Discuss how the Gene Theory is related to sexual cell reproduction and fertilization.	Using diagrams, show simple meiosis on one pair of chromosomes.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
		<u>Simple Meiosis:</u>  <u>Fertilization:</u>  Note: Students should be made aware that during fertilization there could be four recombinations for chromosomes.
5. A dominant trait is visible while the recessive trait is hidden.	a) Distinguish between dominant and recessive traits.	The ability to roll the tongue (tongue roller) is a dominant trait to the recessive (non-roller). Students can gather data for this trait within their own classroom.
	b) Identify dominant and recessive traits by means of symbols.	Use the same letter of the alphabet. The dominant gene is a capital letter while the recessive is lower case, e.g., free ear lobes are dominant. This would be shown as "E." Attached ear lobes are recessive. This would be shown as "e."

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
	c) Distinguish between homozygous and heterozygous traits.	Have students develop an understanding that homozygous indicates identical gene combinations and heterozygote indicates two different genes, e.g. (E,E) as compared to (E,B).
	d) Distinguish between phenotype and genotype.	Have students determine that genotype refers to the genetic makeup whereas phenotype refers to the outward appearance.
6. One can predict the possible combination of genes for the next generation of offsprings.	a) Describe the procedure for solving genetic problems.	Note: Only do single trait predictions. Key: T -- tall (dominant) t -- tall (recessive) Parental genotype: TT x tt Meiosis or sexual cell division: (Sex cell) TT < T, T X (Sex cell) tt < t, t Punnett square: t t T Tt Tt T Tt Tt Interpret the Punnett square. For example: Parents: mother (T, T) is homozygous tall father (t, t) is homozygous short

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
		The first generation offspring: genotype: 4 heterozygous tall phenotype: 4 tall
	b) Solve genetics problems involving single dominant-recessive traits.	Have the students solve some simple trait problems, e.g., cross a pure black guinea pig with a pure white guinea pig (black is the dominant trait).
Enrichment		
1. Plant and animal breeders are constantly introducing new varieties.	a) Discuss the importance of the need for a continuous breeding program for plants. **	Choose one of the cereal crops, wheat, oats, barley or canola, and have the students identify some reasons as to why the plant breeders work is continuous. As new varieties are being introduced, it is possible the replacement varieties are already in a stage of testing. Information may be obtained from the Agricultural Research Centre at the University of Manitoba, Morden and Brandon.
2. Technological advances have altered the normal process of reproduction.	a) Discuss how microscopes and microtechnology has altered normal reproduction by such processes as:** . test-tube or invitro fertilization, . artifical insemination of animals, . genetic engineering of a plant--triticle.	

GRADE NINE: EARTH SPACE AND TIME: THE CHANGING EARTH'S CRUST



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GRADE NINE: EARTH, SPACE AND TIME: THE CHANGING EARTH'S CRUST

RATIONALE: A study of the changing Earth's Crust provides a excellent opportunity to observe the Nature of Science. The theories concerning the structure of the Earth's Crust and a Model of the crust have changed drastically during the 20th century. Modern technology has played an major role in providing evidence which brought about changes in theories. The new model of the Earth's Crust has enabled scientists to better explain the occurrence of volcanoes, earthquakes, mountain building.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/REFERENCES
	The student should be able to:	
1. Prior to 1915, Geologists accepted the theory that the continents and oceans were fixed or permanent.	a) Describe the permanent structure of continents and oceans.	Classroom discussion as the early beliefs that ocean floor and continents were same age and permanent (unchanging).
2. More than 200 million years ago, Pangaea, a super-continent existed and this continent broke apart with the continents drifting out to their present locations.	a) Discuss Wegener's proposals made in 1915 of: . existence of Pangaea; . Theory of Continental Drift.	Use literature, present maps showing Pangaea. Discuss Wegener's proposal of continental drift. Make the students aware of the fact that his proposals were not readily acceptable because of lack of scientific technological evidence. Also, he could not explain how or why the continents drifted. He assumed that the age of continents rocks and ocean floor rocks were different.
	b) Demonstrate that there appears to be a fit to the continents.	Cut out existing continents from a map and attempt to reconstruct Pangaea. Fit the continents like a jig-saw puzzle.

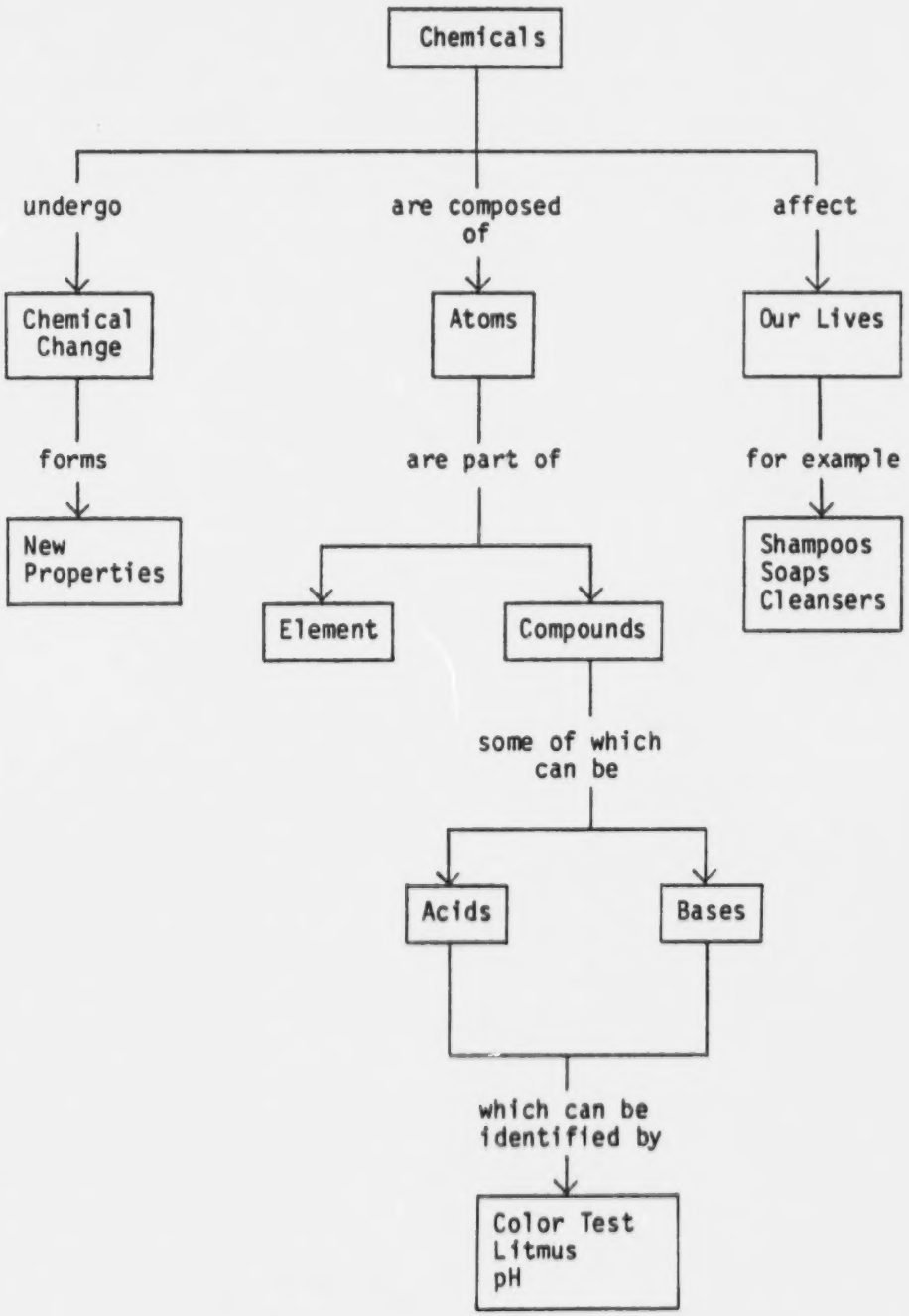
CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/REFERENCES
	(Nature of Science: Tentativeness - problem with data?)	Have students propose reasons why the fit is not perfect. Inform the students that a better fit occurs when dealing with continental shelves. Simple examples of the problems with correlation?
	c) Infer reasons as to why there is not a perfect fit to the continents.	
	d) Discuss the evidence presented by Wegener to support his proposal.	Cite examples of similarities such as between the Appalachian Mountains in North America with ranges found in Scotland and Norway. Existence of diamonds in Africa and South America. Discovery of coal in Antarctic.
	. Similarities of rocks and rock formation.	
	. Fossils.	Students should note that marsupials are found in Australia and North America. Monkeys are found in Old World (Africa) and New World (South America).
	. Occurrence of similar plants and animals on different continents.	Is the evidence sufficient to propose a theory?
		Brainstorming to come up with proposal theories.
3. The Earth's crust is made up of six large and numerous small plates.	a) Discuss the theory of Plate Tectonics.	Present maps showing the proposed plates.
		Stress that one proponent of the theory is Canadian Geophysicist Tuzo Wilson.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/REFERENCES
4. Technology provides the evidence to support the Theory of Plate Tectonics.	a) Indicate how technology and technological devices have provided evidence to support plate tectonics.**	
	. Sonar equipment.	Use pictures of sonar and also of underwater irregularities (mountains, trenches). Discuss how sonar has enabled a mapping of the ocean floor.
	. Submersibles, mini-subs.	Use pictures. Discuss with students how mini- subs provide evidence, gather samples, house cameras.
	. Underwater photography.	
	. Radioactive dating of rocks to establish age difference between continental and ocean floor rocks.	Discuss how the radio active dating process provided evidence that continents could have drifted.
	. Seismographs and earthquakes - identifying fault lines.	Provide maps of earthquakes. Superimpose the the earthquake maps onto maps showing the plates. Describe how seismographs have identified fault lines. Make a seismograph.
	. Deep sea drilling.	Provides the evidence of the earth's mantle and its effects on the plates.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/REFERENCES
5. The earth's crust is made up of four layers.	a) Describe the four layers that make up the earth's crust.	
	b) Develop a model of the Earth's crust.	Earth's outer crust is composed of six large and numerous small plates. These plates are floating on denser, flexible solid called mantle.
	c) Demonstrate a flexible solid.	Use plasticine which has been warmed. Observe what happens when one exerts pressure to one part of the plasticine.
	d) Relate the changing Earth's crust to forces and pressures which are created and dispersed in the core and mantle of the earth.	Make jelly and just before it hardens, observe the fact that objects can actually be suspended or will float in this semi-hard jelly. Discuss how the heat from the core causes convection currents which create movement in the mantle. This mantle motion causes a constant movement of the plates.
6. The movement of one segment of the earth past another is called an earthquake.	a) Define the word: earthquake.	
	b) Describe how an earthquake can be caused.	
	c) Discuss the role of seismology and seismographs in reading earthquakes.**	Describe the P-primary and S-secondary waves. Using a rope or string, demonstrate the P and S waves.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/REFERENCES
	d) Describe earthquake destruction, relative to Tsunamis.	Look at an atlas and observe the regions where earthquakes are prevalent.
	e) Relate how earthquakes provided evidence for tectonics theory and how tectonics explain earthquakes (enhance our understanding of).	
7. Various forces cause mountain formation.	a) Describe the forces which are responsible for building mountains.	
8. Various forces are responsible for volcanic eruptions.	a) Describe how a volcano is formed and the forces responsible for volcanic eruption.	Refer to Mount St. Helen, and the effects of this volcanic eruption on Western Canada.

GRADE NINE: CHANGES IN MATTER AND ENERGY: CHEMICAL INTERACTIONS



GRADE NINE: CHANGES IN MATTER AND ENERGY: CHEMICAL INTERACTIONS

RATIONALE: All matter is composed of elements. These elements are found as atoms or molecules. The atoms can combine to make compounds. This unit will focus on the chemical composition of matter. Students will be exposed to simple chemical reactions to gain an understanding of how the elements combine. Daily lives are affected by chemicals and how they react.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
	The student should be able to:	
1. A chemical change causes a change in the nature of the particles.	a) Describe and identify a chemical change.	Moisten steel wool and let it stand in a partially closed jar for a couple of days and note the chemical change due to rusting has changed iron to iron oxide.
	b) Distinguish between a chemical and a physical change.	Demonstrate by burning a candle, trapping the gas and testing for CO_2. (Limewater test). Note what has happened to the candle.
	c) Describe the identifying characteristics of chemical and physical changes: gas production, energy release, precipitates formed.	When doing chemical change activities, note that new substances with different properties form in place of other substances which no longer can be detected.
2. Energy may be required or released in a chemical change.	a) Define exothermic and endothermic.	Class discussion to show how reactions are brought about by adding heat. (Baking a cake).
3. The atom is the basic unit of matter.	a) Define atom.	Refer to reference material.
	b) Describe a simple model of the atom (Bohr): . electrons . protons . neutrons	

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
4. Elements can be classified and represented by chemical symbols.	a) Define the term element. b) Describe and classify elements as metals or non-metals. c) Write the symbols for common elements.	Refer to the periodic table to show how the elements are in groups, the symbols.
5. Compounds can be represented by a chemical formula.	a) Define the term compound. b) Name and write the formula for some simple compounds.	Write the names, formula of some of the most common compounds, (H_2O, CO_2, NaCl).
6. Chemical reactions are a combination of reactants and the production of new substances.	a) Describe the characteristics of chemical change, reactants, new substances, energy changes.	
7. Matter is conserved during a chemical reaction.	a) Distinguish between synthesis and decomposition. b) Write simple equations representing reactions such as burning, synthesis of water. c) State the Law of Conservation of Mass.	Students should understand that a chemical breakds down or decomposes into simpler substances, e.g., H_2O into hydrogen and oxygen. Similarly, simple chemicals combine to form new chemicals, e.g., hydrogen and oxygen combines to form water.

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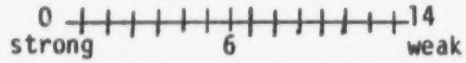
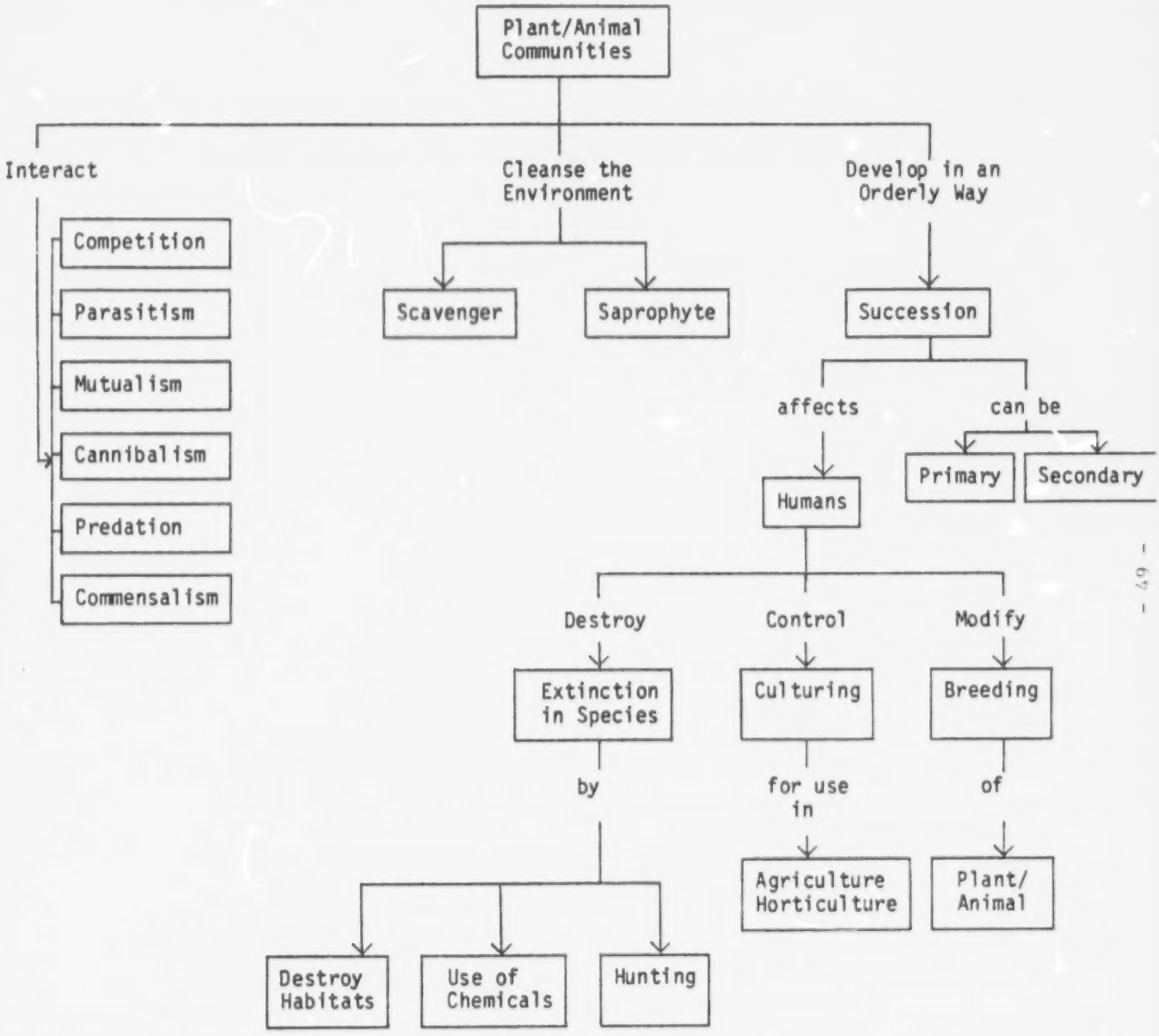
CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
8. Acids and bases can be identified by chemical tests and indicators.	a) Describe identifying characteristics of acids and bases.	
	b) Test for acids and bases.	Use litmus paper, phenolphthalein, bromothymol blue, pH paper.
	c) Test and classify common household items as acids or bases.	
	d) Determine the pH of common substances.	
	e) Describe the pH scale.	
9. Chemicals have affected our lives in the home.	a) Identify acids and bases around our home.	Examine household labels. Refer to pH balanced shampoos.
	b) Identify hazards in various household products.**	Discuss the necessity of safe use of chemicals in the home.
10. Chemicals have been devised for specific purposes.	a) Describe chemicals which have been devised for specific purposes.**	Include soaps, deodorants, cleansers and polishers in discussion.
11. Each chemical may have advantages and disadvantages.	a) Assess the advantages and disadvantages of chemical use.**	Discuss salt on concrete.

GRADE NINE: INTERDEPENDENCY AND INTERACTION AMONG ORGANISMS: PLANT AND ANIMAL INTERACTION



GRADE NINE: ENVIRONMENTAL INTERDEPENDENCY AND INTERACTION AMONG ORGANISMS: PLANT AND ANIMAL INTERACTIONS

RATIONALE: A study of the interrelationships which can occur between individual populations of plants and animals - some beneficial, others harmful. The environment is constantly changing and this results in succession or changes in the biotic communities. The students will examine and discuss the role of humans in the environment as we manage or cause some life forms to become extinct but on the other hand, change and culture other life forms.

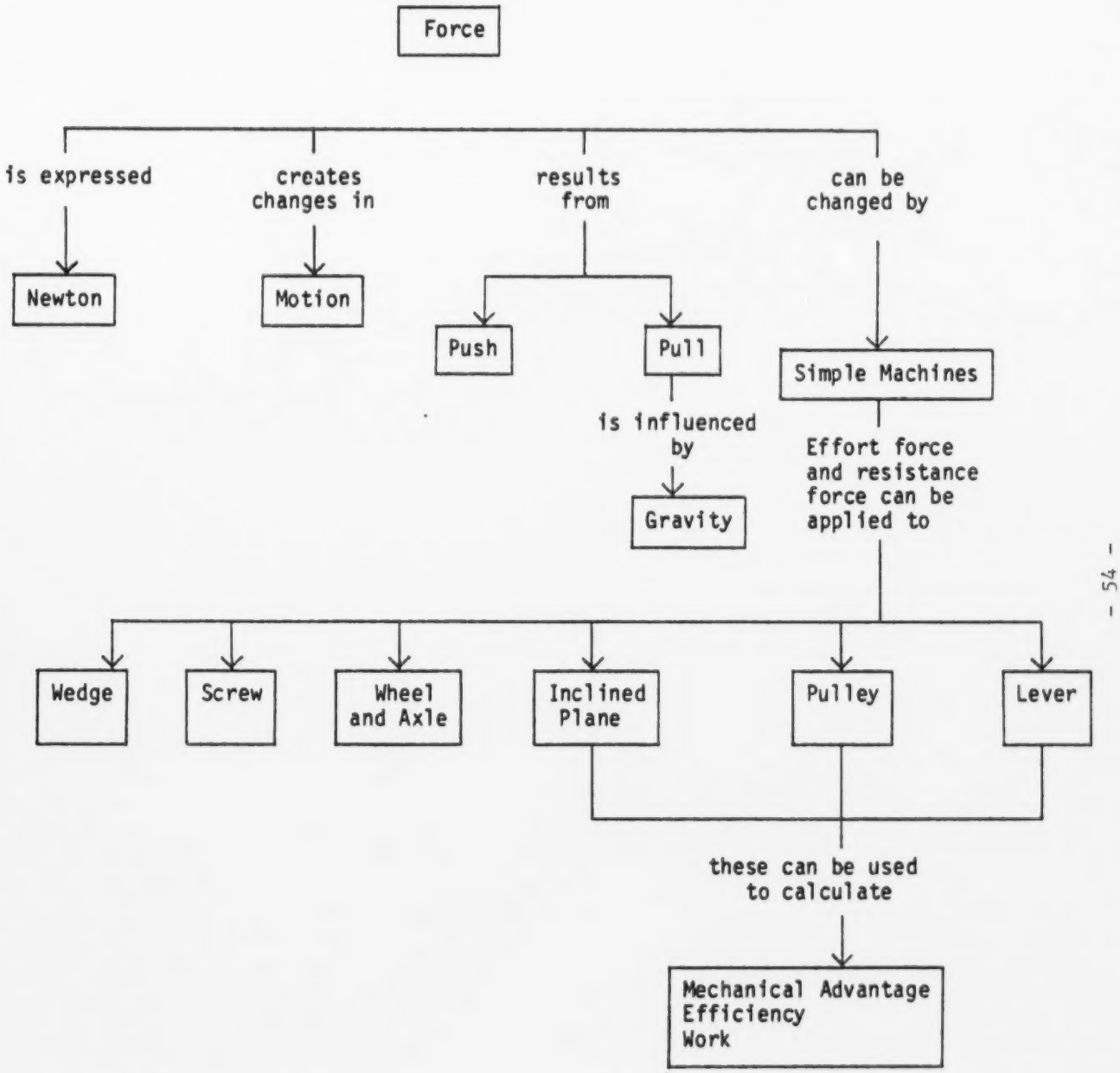
CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
PLANT AND ANIMAL INTERACTIONS IN THE ENVIRONMENT		
	The student should be able to:	
1. Biotic and abiotic factors interrelate in an ecosystem.	a) Differentiate between abiotic and biotic factors in studying an ecosystem.	Bring in rotten logs and have the student analyze the biotic and abiotic components. Review Grade 7. Carefully remove moss from the bottom of a tree. Analyze the biotic and abiotic components.
2. Plants and animals interact with one another by competition, parasitism, mutualism commensalism and predation.	a) Define the relationships. . Competition. . Parasitism. . Mutualism.	Set up growth competition experiments by using birdseed, wheat, other cereal grains. Collect and dissect insect galls from willows, goldenrods, etc. . Study ant/aphid; bee/flower. . Collect lichen samples from rocks, trees.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
	. Commensalism.	
	. Cannibalism.	State examples of cannibalism.
	. Predation.	Discussion of predator/prey relationship and implications to an ecosystem.
3. Some members of the ecosystem rid the system of dead/decaying plants and animals.	a) Define and state of role in ecosystems of: . reducers/saprophytes; . scavengers.	
4. Energy is removed from the system as one proceeds along a food chain, web or pyramid.	a) Develop the food chain, web, pyramid.	Class discussion. As one moves through the chain, there is a loss of energy (unavailable for next rung).
5. Succession is the change in the biotic communities brought about by changes in the abiotic and biotic systems.	a) Define succession and explain how it controls the development of a natural community.	Refer to an area close to your local region where succession has been and is occurring. For example a pond, barren rock area, forest, meadow. Discussion on weathering of rocks and soil formation, pH, light.
	b) Discuss how abiotic and biotic changes affect succession.	Students should discuss how biotic changes bring about plant changes which result in animal changes. Note that competition is very important. Climax in a succession should be discussed.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
A secondary succession occurs when a primary succession has been interfered with.	c) Describe primary succession and infer factors which can cause secondary succession.	Have the students develop a primary succession in a forest, on a volcanic island, vacant lot, newly formed pond.
Human communities affect natural succession of an area.	d) Describe how humans affect the natural succession of areas such as a marsh or a forest.**	Use books and pamphlets from Delta marshes, Manfor to show the positive and negative effects of humans interfering with natural succession.
ROLE OF HUMANS IN THE MANAGEMENT AND CONTROL OF PLANTS AND ANIMALS		
6. Humans have caused plants and animals to become extinct.	a) Discuss how humans have caused species to become extinct (destroyers).**	
	. Destroying natural habitat and food.	- Small group discussion. - Pictures of extinct species and near extinct.
	. Hunting.	- Visit a zoo and pay careful attention to the vanishing species.
	. Use of chemicals: - herbicides - pesticides.	
7. Humans control plant and animal communities by culturing. Example	a) Discuss how humans have controlled the plant and animal communities (controllers).**	(Management). Give several options. Deal with chemicals, land use.
	. Culturing of plants and animals through agriculture, horticulture.	Refer to various culture techniques. Agriculture, animal husbandry, plant horticulture, etc.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
8. Humans produce or change species by breeding (genetics).	a) Discuss how humans change the animal/plant communities by plant breeding and animal breeding (modify).**	Discussion on genetically producing new varieties, strains, species of plants, and animals. Examples: Triticale, mule, beefalo and new varieties of cereal grains and vegetables. This section can be presented by students looking at issues and arriving at decisions about the role of humans in ecology. Students could become involved in debates or present arguments in favour of a position (against) without a formal debate. Students could make oral or written presentations. (Correlate with language arts.) 1) Hunting, as a sport, should be banned (positive or negative). 2) Farmers should not be allowed to burn stubble. 3) Humans are using too many chemicals to control pests, weeds. 4) Insecticides, herbicide, pesticide use should be encouraged. 5) Aerosol sprays are bad for our environment. 6) Too much money, time and effort are spent on plant and animal breeding. 7) Breeding provides a balance for organisms which we are causing to become extinct. 8) Marsh land, sloughs should be drained to have more agricultural land.

GRADE NINE: CHANGES IN MATTER AND ENERGY: FORCE—WORK AND MOTION



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GRADE NINE: CHANGES IN MATTER AND ENERGY: FORCE-WORK AND MOTION

RATIONALE: A force is exerted on an object to cause a change in position or in motion. This unit deals with the use and measure of force to create these changes. Work is only done when an object moves due to an applied force. Machines make work easier. The students will study 3 of the 6 basic machines, lever, phone, and pulley to determine where force has to be applied and the resistance force calculations of input, work, output work, M.A. and efficiency will be done by students.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/REFERENCES
	The student should be able to:	
1. A force is a push or pull exerted on an object. (Review)	a) Define operationally the term force.	Classroom discussion. Demonstrate act of push and pull on common objects in classroom.
2. Force causes a change when acting on objects. (Review)	a) Demonstrate that a force can cause a change:	Have students make a list of examples such as:
	. in shape;	Pluck a string on an instrument.
	. set a stationary object in motion;	Start a ball rolling, push a book.
	. speed up motion;	Add a push to a rolling ball.
	. slow down motion;	Push a block/book/ball to start it rolling. Why does the motion slow down?
	. stop motion;	Throw a ball to a student who catches (stops) the ball.
	. change direction of motion.	Hit a ball with a bat.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/REFERENCES
3. Gravity is a force.	a) Observe that gravity is a force of attraction.	small mass spool large mass - Spin the small mass, what happens to large mass. - Stop the small mass from spinning, large mass pulls it down into the spool.
	b) State that the pull of gravity is constant.	Have students do activities on finding the centre of gravity.
	c) State that weight is a measure of gravity.	Classroom discussion on a presentation of Galileo's experiments on the gravitational effects on objects of uneven mass.
	d) Identify the constant acceleration of gravity as 10 m/sec2 (approximately).	
4. Unbalanced forces create motion.	a) Observe that unbalanced forces create motion, balanced forces do not.	Do activities with blocks and spring scales using different surfaces.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/REFERENCES
5. The standard unit for measuring force is the Newton.	a) State the Newton as a unit of force.	Class discussion.
	b) Measure the force required to push, pull, lift objects.	Use a Newton scale or a spring scale to measure force required to move objects. Examine how the scale is constructed and how it works. <u>Note</u>: Use 10 N/Kg rather than 9.8 N/Kg simplifying conversion on spring scale.
6. There are six basic simple machines.	a) Identify the six simple machines (define operationally).	Use pictures or actual examples to demonstrate the 6 machines incline plane, lever, pulley, wedge, wheel and axle, screw.
	b) Identify simple machines in our homes.**	When students are listing these machines emphasize those which are used in their surroundings.
7. Each simple machine has an applied or effort force which results in a resistance force.	<u>Incline Plane</u> a) Identify the effort force and resistance force on an incline.	Carry out activities using wooden blocks and a board for the incline.
	b) Measure the effort force required to lift objects.	
	c) Describe use of inclines in road construction, ramps.**	

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/REFERENCES
	<u>Lever</u>	
	a) State the parts and the law of the lever.	Use a single 1st class lever, develop the idea of the fulcrum with respect to the resistance and have students predict if more or less force will be required.
	b) Measure the effort force required to lift objects using the lever.	
	c) Identify 3 classes of lever.	Use actual tools/pictures etc.
	<u>Pulley</u>	
	a) Identify effort force and resistance force on a pulley.	Discussion.
	b) Measure the effort force required to lift objects using a fixed and moveable pulley system.	Do activities using single or two pulley systems. Attach pulleys in fixed and moveable pulley system.
	c) Compare the effort force of a single fixed pulley system with a moveable pulley system.	
	d) Describe the use of the block and tackle.	
	e) Describe how the pulley system is used in elevators.**	

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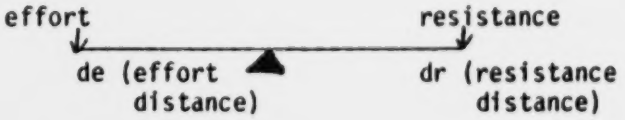
CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/REFERENCES
8. Mechanical advantage is a measure of how much a machine changes force.	a) Define the mechanical advantage.	Do activities in which the resistance and effort can be recorded. Then determine the mechanical advantage. $MA = \frac{\text{Resistance Force}}{\text{Effort Force}}$
	b) Calculate (compute) the M.A. of incline plane, lever and pulley.	Use data collected in Activity measuring effort force required to move specific masses (resistance) in previous objective.
	c) Estimate the M.A. of a pulley system by counting the support strings.	Calculate the M.A. of simple pulley system and compare these calculated M.A.'s to estimate of M.A. by counting support strings.
9. Work is done only when an object has been moved against a force.	a) Define operationally the term, <u>work</u>.	Classroom discussion. Introduce the idea that in order for movement to occur, forces are required and that movement implies distance moved. work = effort force x distance object moves $W = F \times D$
	b) State the Joule as being a unit of work.	Class discussion.
	c) Compare output work with input work.	Class discussion.
	d) Compute work done by using an inclined plane, lever, pulley system.	Set up a simple incline and pull an object to the top of the incline. Students will measure length of incline and record force required (newton-metre). Use data to calculate work.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/REFERENCES
		Repeat procedure using levers and pulley systems. (Teacher prepared problems).
10. Efficiency is the useful work done by a machine.	a) Define operationally the efficiency of a machine. b) Identify four measureable variables required to calculate efficiency. c) Compute the efficiency of an incline, a lever, and pulley.	Students are working with four variable measurements and calculations.  $\text{Efficiency} = \frac{\text{output}}{\text{input}}$ $E: \frac{\text{resistance} \times \text{distance of resistance}}{\text{effort} \times \text{distance of effort}} \times 100$ Set up an incline, pulley system, have students measure the effort, resistance distance of effort, distance of resistance. Use these measurements to compute efficiency.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/REFERENCES
11. Friction effects the efficiency.	a) Infer how friction effects the efficiency of a machine. b) Identify variables which can decrease friction and increase the efficiency.	
ENRICHMENT:		
1. Conditions may be varied to increase the efficiency of an incline.	a) Measure the required force or effort when varying: . Angle of incline. . Surface composition: - graph the effort force and angle of incline; - find the critical angle of different surfaces and an incline.	
2. Pulleys attachment effects the mechanical advantage.	a) Design pulley systems which would require the least effort or force to lift an object.**	
3. A complex machine is made up of two or more simple machines.	a) Identify the simple machines which have been combined to produce a complex machine.	

APPENDIX "A"

GENERAL PROGRAM OVERVIEW K-4

THEMES	K	1	2	3	4
ENVIRONMENTAL INTERDEPENDENCY AND INTERACTION AMONG ORGANISMS	LIVING AND NON-LIVING	ANIMALS AS LIVING ORGANISMS --- PEOPLE ARE LIVING ORGANISMS	LIVING ORGANISMS IN THE ENVIRONMENT	LIFE CYCLES	POPULATION INTERACTIONS
CHANGES IN MATTER AND ENERGY	PROPERTIES OF OBJECTS	PROPERTIES OF MATTER	FLOTATION: A PROPERTY: OR MATTER	CHANGES IN MATTER --- ENERGY, HEAT AND TEMPERATURES --- AIR AND AIR PRESSURE	ELECTRICITY --- SOUND --- STRUCTURES
EARTH, SPACE AND TIME	SIZE, POSITION AND TIME	COMPARING AND MEASURING EVENTS	MEASURING TIME, OBJECTS AND POSITION --- LIGHT AND SHADOWS	THE EARTH, SUN AND MOON	WATER AND LAND

5	6	7	8	9
ADAPTATIONS TO ENVIRONMENT	INTERACTIONS OF POPULATIONS WITH ENVIRONMENT	MICROBES AND ECOSYTEMS	CELLS AND ORGAN SYSTEMS PLANTS AND THE ENVIRONMENT	REPRODUCTION AND HEREDITY PLANT AND ANIMAL INTERACTIONS
ELECTRIC CHARGES FORCE AND MOTION PHYSICAL AND CHEMICAL CHANGE	FORCE AND MOTION SIMPLE MACHINES	LIGHT PHYSICAL PROPERTIES AND PHYSICAL CHANGES OF MATTER	HEAT ALTERNATIVE FORMS OF ENERGY FLIGHT	FORCE, WORK AND MOTION CHEMICAL INTERACTIONS
THE CHANGING EARTH	WEATHER THE EARTH IN SPACE	ROCKS, MINERALS AND SOILS THE OBSERVABLE UNIVERSE		CHANGING EARTH'S CRUST

APPENDIX "B" SCIENCE PROCESSES DEVELOPMENT: K-9

PROCESSES	K-3	4-6	7-9
1.0 Observing			
1.1 Identity and state properties and changes in an object using senses	ID	D	E
and events	ID	E	E
1.3 Identify and describe elements of a system, motion of an object relative to a reference point	I	D	E
1.4 Distinguish between qualitative and quantitative observations		ID	E
1.5 Distinguish between observation and inference		I	DE
2.0 Measuring			
2.1 Select and use appropriate instruments with precision. Use SI	I	ID	ID
2.2 Design and construct simple measuring devices (measuring time, scales, hygrometers)		I	I
2.3 Calculate the efficiency of simple machines			ID
3.0 Classifying			
3.1 Distinguish between objective and subjective information, fact and inference			ID
3.2 Sort objects into groups according to similarities and differences and/or quantitative measurements	I	ID	DE
3.3 Develop classification systems	I	I	ID
3.4 Use a dichotomous key			I

CODE: I - Introduced to a limited degree.
D - Developed into new areas or in more complex forms.
E - Extend process (student controlled and directed).

SCIENCE PROCESSES DEVELOPMENT: K-9

PROCESSES	K-3	4-6	7-9
4.0 Inferring			
4.1 Identify observations which support an inference	I	ID	DE
4.2 Describe additional observations needed to test alternative inferences	I	ID	DE
4.3 Identify inferences that should be accepted, rejected or modified on the basis of additional observations		ID	DE
5.0 Communicating			
5.1 Describe and sequence a series of events orally or in writing	ID	DE	E
5.2 Construct a simple data table or graph	I	DE	E
5.3 Construct a line graph and represent principles using a mathematical format		ID	D
5.4 Write an accurate report describing events		I	D
6.0 Predicting			
6.1 Make and confirm simple predictions using an activity	ID	E	E
6.2 Predict the consequences of removing or altering one or more system-components		ID	DE
6.3 Interpolate and extrapolate from patterns or graphs; predict from formulae		I	D
6.4 Design tests for predictions; maintain, remove, or modify predictions		I	DE

CODE: I - Introduced to a limited degree.
D - Developed into new areas or in more complex forms.
E - Extend process (student controlled and directed).

SCIENCE PROCESSES DEVELOPMENT: K-9

PROCESSES	K-3	4-6	7-9
7.0 Interpreting Data			
7.1 Distinguish between relevant and irrelevant data using observation, reading, or listening	I	ID	DE
7.2 Recognize limits of data, biases and their distortions		I	D
7.3 Interpret cause and effect relationship within a problem solving situation, construct inferences from data		I	D
8.0 Recognizing and Identify a Problem			
8.1 Recognize patterns and events	I	D	D
8.2 Delimiting and phrasing a problem		ID	DE
9.0 Controlling Variables			
9.1 Identify relevant variables manipulated and responding to test a given hypothesis		ID	DE
9.2 Examine collected data and select relevant data		I	D
9.3 Identify variables (manipulated and responding from observations)			ID
10.0 Hypothesizing			
10.1 Distinguish between a) opinion and hypotheses		I	D
b) hypotheses, theory and law			ID
c) inferences and hypotheses			D
10.2 Identify a testable hypothesis and revise when indicated by data		I	DE

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SCIENCE PROCESSES DEVELOPMENT: K-9

PROCESSES	K-3	4-6	7-9
11.0 Operational Definitions			
11.1 Construct definitions on the basis of changes which occur or what an object does or how it is used	ID		DE
11.2 Contrast an operational definition with a non-operational definition	I		DE
11.3 Construct operational definitions	I		DE
12.0 Designing an Experiment			
12.1 Recognize the manipulated and responding variables			ID
12.2 Design, conduct and report an experiment using appropriate techniques			DE
13.0 Formulating Models			
13.1 Identify similarities and differences in the models of two systems	ID		D
13.2 Generate spatial models	ID		E
13.3 Generate mathematical models			ID

CODE: I - Introduced to a limited degree
D - Developed into new areas or in more complex forms
E - Extend process (student controlled and directed)

APPENDIX "C" **SCIENCE PROCESSES DEVELOPMENT - PROBLEM SOLVING: K-9**

PROBLEM SOLVING	K-3	4-6	7-9
1.0 Apply appropriate questions when a problem is stated	I	ID	E
2.0 Transform information into a representation illustrating a solution		I	DE
3.0 Recognizing alternative factors affecting possible solutions and propose strategies for solution		I	D
4.0 Establish criteria for judging a solution		ID	E
5.0 Collect, analyze and synthesize relevant information		ID	DE
6.0 Identify alternate models or drawings to illustrate a solution to a problem		I	D
7.0 Recognize, and define a problem in a researchable format			ID

CODE: I - Introduced to a limited degree.
D - Developed into new areas or in more complex forms.
E - Extend process (student controlled and directed).

APPENDIX "D"

OBJECTIVES AND CONCEPTS FOR SCIENCE-TECHNOLOGY AND SOCIETAL INTERACTIONS

CONCEPTS	PROGRAM OBJECTIVES
SCIENCE AND TECHNOLOGY	
- Science is the process of increasing and testing our knowledge of the natural world; enables us to predict the outcome of events in the natural world. - Technology is the process of using resources and scientific knowledge to develop products and/or processes which attempt to resolve problems and/or needs of society. - Science and technology advance one another. Technological processes are sometimes invented without knowledge of the scientific principle behind them.	The student will be able to: - Distinguish between science and technology. - Identify the principle(s) upon which simple technologies are based. - Identify examples of interdependence between science and technology.
NATURE OF TECHNOLOGY	
- Some technolgical devices and processes can be viewed as systems, or a series of simpler devices working as a system. - Technological processes and devices extend the abilities of humans and affect the environment. - A technological process or device often builds on past ones, becomes obsolete or can be changed and improved. Improvement may decrease the cost of the process.	- Identify the components of a functioning technological system including input, output, feedback and control. - Describe ways technological processes are related and extends the abilities of humans. - Explain why some processes become obsolete.

CONCEPTS	OBJECTIVES
INTERACTION OF SCIENCE, TECHNOLOGY AND SOCIETY	
- Changes in either science-technology or society has often affected the other.	- Demonstrate how science, technology and society are interrelated, it has improved the standard of living, imparted jobs and careers.
- Refinements in processes has resulted in new products to change lifestyles and industry.	- Describe that science and technology alone cannot solve society's problem.
- New industries may be created and others become obsolete, affect career choices, employment and education needs.	- Demonstrate that a technological process or device may be developed due to individual or societal needs and may be accepted or rejected because of societal attitudes.
- A technological process or device is usually developed in response to needs; however, sometimes the device is developed and the need created by marketing.	- Identify how technological advances have affected the interactions of nations.
- Technological advances have had global impacts.	
MAKING DECISIONS	
- Technological processes and devices offer increased choices. The purpose of a process and the choice made for its use determines its impact on society.	- Describe probable long and short-term consequences of a technological process or device.
- Decisions should be based on long and short-term consequences. Resolution of complex issues requires data from experts in many disciplines. Experts often disagree about solutions.	- To assess and accept or reject a particular technological process or device based on its advantages and disadvantages.
- Trade offs are sometimes made between the advantages and disadvantages for people and the environment. Some burdens are accepted because benefits outweigh them.	- Demonstrate some alternative solutions to technological issues.

CONCEPTS	OBJECTIVES
- A decision about a technological process or device leads to other questions and issues. Resolution of an issue may not be acceptable to all persons and groups.	
- Governments sometimes pass laws to regulate and control use of a technological process e.g. seat belts, nuclear power. Growth of science and technology is affected by public funding decisions.	Cite examples of legislation which has been passed to regulate a technological device.

APPENDIX "E" K-9 SCIENCE, TECHNOLOGY AND SOCIETY CONTENT

OBJECTIVES	K-3	4-6	7-9
Students will be able to:			
SCIENCE AND TECHNOLOGY DEFINED			
Distinguish between science and technology		I	D
Identify scientific principles upon which a simple technology is based		I	D
Identify examples of interdependence of science and technology			ID
Identify components of a functioning technological system with inputs, outputs, feedback, control		I	D
NATURE OF TECHNOLOGY			
Describe how technological processes or devices are related to one another		I	D
Explain how technology extends the abilities of human beings and affect the environment	I	D	D
Explain how and why a technological process or device becomes obsolete or is modified		I	D
Demonstrate how science, technology and science interrelate, has affected living standards and imparted on jobs or careers			ID
INTERACTION WITH SOCIETY			
Recognize that science and technology alone cannot solve society's problems			ID
Demonstrate that processes and devices are sometimes developed in response to needs	I	D	D
Demonstrate that certain processes or devices are not accepted because of societal attitudes			
Identify advances in technological processes and devices that result in nations interacting as communities such as acid rain, satellite television			ID
DECISIONS			
Describe probable long and short term consequences of a technological process or device - increased choices, advantages and disadvantages			ID
Assess a process or device based on short and long-term consequences			ID
Demonstrate that several solutions may exist to technolgical issues			ID
Cite examples in which legislation has been passed to regulate a process or device			

CODE: I - Introduced to a limited degree
D - Developed into new areas or in more complex forms.
E - Extend process (student controlled and directed).

APPENDIX "E"

USES OF COMPUTERS IN SCIENCE

1. Tools
2. Experimentation
3. Simulation
4. Computer Assisted Learning (CAL)

Definitions

Tools - software which assists teachers or students to manipulate or manage information. Examples include word processors, databases, spreadsheets, graphics-generation software, and teacher utilities.

Experimentation - computer hardware and/or software used for the collection and preparation of data for analysis. Using hardware input devices, measurements such as temperature, light intensity, PH, electric current, and time could be gathered directly by the computer.

Simulation - courseware which imitates a system (ecology, astronomy), a process, training (balances, oscilloscope, titration), or an experiment (for reasons of cost, hazard, duration, etc.), or courseware which provides abstract simulations from, say, chemistry or physics.

Computer Assisted Learning (CAL) - courseware whose main purpose is either to teach concepts or skills (tutorials) or for drill and practice.

Problem solving and the problem-solving process are acknowledged as an integral part of K-9 science and as such they are not identified separately in this discussion.

Computers are not a substitute for a well-balanced science program. However, computer courseware can enrich the science curriculum and if the courseware has been well developed it can help to make science instruction more effective. Teachers are encouraged to evaluate available courseware to determine its effectiveness prior to making a purchase.

APPENDIX "G"

SAFETY IN SCIENCE

The science program has been designed to stimulate interest in the students by performing many hands-on activities. Positive attitudes towards safety and the proper use of laboratory equipment must be developed in the students. The major causes of accidents are negative attitudes towards safety and carelessness.

Although the majority of the topics and activities are relatively safe, the onus is on the administration and the teacher to ensure safe laboratory experiences. A safe laboratory must have safety equipment and safety instruction as to the use of the equipment.

A complete list and description of safety equipment and safety procedures may be found in Safety in Science, Curriculum Support Series. The manual is available through Manitoba Education.

WOMEN IN SCIENCE

The role of the female in science has not kept pace with the expanding effect of science and technology on society. A concerted effort is needed by all educators to change the attitude of early adolescent females towards science and their roles in the scientific community. Educators must make a conscious effort to eliminate the unconscious bias that exists in classrooms towards women in science.

Guidelines for Addressing Sexual Bias in Classrooms

Teachers can:

- use inclusive, rather than exclusive, language.
- assure that textbooks, reference materials, films, videos, visual displays give equal consideration to both sexes in career and lifestyle portrayals.
- be aware that habit and tradition may result in different teacher expectations for girls than for boys and that the students own expectations may be reflected in their success rates. Both expectations may be communicated subtlety and may, therefore, be difficult to detect and correct.
- be aware that studies have shown that boys receive considerably more teacher feedback, occupy more physical space, are more critical of girls and of each other, and generally assume the leadership role in a mixed group. This has implications for almost every aspect of classroom management and methodology.
- question not just the content of a curriculum, which often ignores or gives little attention to women's contributions, but the context and definition of success or knowledge, which often predetermines that what is seen as male and what is seen as a contribution are synonyomous.
- encourage projects which recognize skills and interests of both sexes and discourage put-downers or devaluing of "female" interests--by male students.

APPENDIX "H"

SCIENCE FAIRS

A science fair is an exhibition of innovative activities, hands-on experiments and/or scientific research or literature reviews. The most important feature of the science fair is the work of each individual student. The fair is a method or mechanism to display the creative work of the student.

Some of the benefits of carrying out a science fair project include:

- the chance to express creativity and initiative in independent research;
- the experience of the excitement and frustration of scientific research;
- the opportunity to develop special skills in written communication, oral presentation and organization of work.

The work on a science fair project may be divided into three stages.

1. Preliminary planning and choosing of a topic.
2. Research or experimentation. Keep a daily log book.
3. Science fair project--the blackboard and display.

There are excellent publications, Science Fair Project Ideas, The Science Fair Rookie Kit and Handbook of Helpful Hints for Elementary Science Fairs, which are available to interested teachers. Refer to the annotations.

ANNOTATIONS

1. Science Fair Project Ideas--Youth Science Foundation, Suite 805, 151 Slater Street, Ottawa K1P 5H3.

2. The Science Fair Rookie Kit. MSSS. (Available through Manitoba Education and Training.)

3. Handbook of Helpful Hints for Elementary Science--T. Bilyk. (Available through Manitoba Education and Training.)

APPENDIX "I"

BASIC EQUIPMENT LIST

Grades 5 and 6

bar magnet
steel balls
paper clips
metre sticks
washers (different sizes)
spring balance (optional)
plastic pails
balloons
thread
string
paraffin wax
zinc sheets
copper
vinegar
lemon juice
compass
copper wire
steel wire
dry cell
6 volt batteries
sugar
sand
hand lens
microscope
modelling clay
candles
food colouring
bromthymal blue
alka seltzer tablets
yeast
rock samples
plaster of Paris
containers
birdseed
seeds (bean, chickpea)
pulleys
wheel and axle
screw nails
Lego or Mechano set (optional)
flashlight
globe
milk cartons
thermometer
barometer

APPENDIX "J"

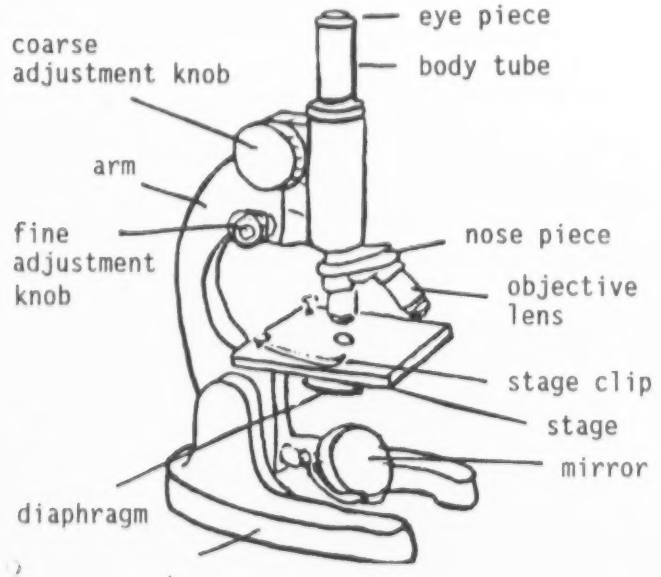
Grades 7, 8 and 9

microscope
microscope slides, cover slips
hand lenses
yeast
thermometers
sugar
yo-yo
pendulum
light bulb
aquariums
flashlight
lens
glass prism
beakers
test tubes
variable size containers
protractor
drinking straws
tape
rubbing alcohol
food colouring
iron filings
mineral set
alum
spring scales
prepared slides of animal and plant cells
slides of blood cells
stop watch
paper clips
newsprint
fan
maps of Canada
map showing Continental Shelf
sand
soil
burners
ring stand
ring
clamps
bimetallic strip
bromothymal blue
litmus paper
pHydrion paper
household soaps, cleansers
shampoo
modelling clay
pulleys
protractor
spring scales
balance scale
gram weight set

APPENDIX "K"

THE MICROSCOPE

The microscope is an essential instrument in the study of living organisms because it enables the student to see things that are too small to be seen with the naked eye. The microscope the student uses in the science class is called a compound microscope because it has more than one lens. The part the student looks through is called the eyepiece and usually has a magnification power of 10X. This means that the object being viewed is enlarged ten times. The lenses attached to the nosepiece are called objective lenses. The number stamped on each lens indicates its magnification. For instance, if the eyepiece magnification is 10X, the total magnification of the microscope is (10X) x (10X) or 100 times.



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These procedures should be followed when using the microscope:

1. Carry the microscope with both hands, one hand under the base, and the other on the arm.

2. Stand facing a light source and set the microscope on the table with the arm toward you.

3. Turn the objective lens with the smallest magnification until it clicks into place under the body tube.

4. While looking through the eyepiece, adjust the diaphragm and the mirror so that the greatest amount of light is coming through the opening in the stage.

5. Place the prepared slide on the stage. Centre the specimen over the opening in the stage and use the stage clips to hold the slide in place.

6. Always look at the microscope from the side as you are using the coarse adjustment knob to lower the body tube until it almost reaches the slide. This will prevent you from breaking the slide and/or damaging the lens.

7. Look through the eyepiece, observe the specimen and slowly raise the body tube until the specimen comes into focus.

8. Always view the specimen with both eyes open. This will prevent eyestrain and allows you to make sketches of your observation without losing sight of the specimen.

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9. Make certain that the body tube is raised, before swinging the high-powered objective into place, so that the lens does not hit the slide.

10. Keep the microscope clean of dust, dirt and spilled fluids. Use lens paper for cleaning the lenses to avoid scratching them.

To prepare a wet mount place the specimen in the middle of a clean microscope slide. (The specimen must be thin enough to allow light to pass through it).

Place a drop of water on the specimen (use a medicine dropper).

Place one side of a clean cover slip at the edge of the drop of water. Slowly lower the cover slip over the specimen and water. (This will prevent air bubbles from forming over the specimen).

RESPONSE QUESTIONNAIRE FOR K-9 SCIENCE PROGRAM OF STUDIES

Please return this questionnaire by January 15, 1992 to the:

Science Consultant
Curriculum Services
Manitoba Education and Training
411-1181 Portage Avenue
Winnipeg, Manitoba R3G 0T3

Please respond to each question in the space provided. (Attach extra sheets if more space is required). Use the page references when making specific comments.

1. Does the guide provide you with sufficient information as to nature and scope of the science program?

_____

_____

2. Are you able to adequately cover the stated objectives within the available class time?

_____

_____

3. Are your students capable of achieving the objectives listed in the unit(s)?

_____

_____

4. Is there sufficient variety in the activities to allow all students to take part in the program?

_____

5. Which activities are too simple or too difficult for the intended grade level?

_____

_____

6. Which activities do not seem to work well?

_____

_____

...../2

7. Which activities require clearer directions?

_____

_____

8. Are there sufficient material resources in your school to enable you to adequately teach the program?

_____

_____

9. Is there difficulty in obtaining science materials in order to carry out the activities?

_____

10. Do the students enjoy or appreciate the program?

_____

_____

11. What are some specific features of the program with which you are pleased?

_____

_____

12. Within the framework of the revised program, please make suggestions which, in your opinion, may result in significant improvements.

_____

_____

_____

_____

_____

NAME: _____ SCHOOL: _____

GRADE: _____ PHONE: _____

THANK YOU FOR YOUR ASSISTANCE.